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ADVANCE OF ASTRONOMY DURING THE NINETEENTH CENTURY.

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ONE of the most remarkable chapters in the astronomy of the past century was commenced on the very first night with which that century began. It was, indeed, on the 1st of January, 1801, that the discovery of a new planet was announced. The five great orbs—Jupiter, Saturn, Mercury, Mars, and Venus—had been known from the earliest times of which we have records, and the planet Uranus had been discovered nearly twenty years before the previous century closed. The solar system was thus thought to consist of these six planets and, of course, the earth. On the memorable night to which I have referred, Piazzi, the astronomer, made a remarkable advance. He discovered yet another planet—the seventh, or eighth, if the earth be included. The new body was a small object in comparison with those which were previously known. It was invisible to the unaided eye, and seemed no more than a starlike point even when viewed through a telescope. It revolved around the sun in the wide region between the orbits of Mars and Jupiter. This discovery was speedily followed by others of the same kind, and, as the century has advanced to its close, the numbers of these planets—asteroids, as they are generally called—has been gradually increasing, so much so that now, of these little bodies known to astronomers, the number amounts to about four hundred and fifty.

But just as the beginning of the century was heralded by the discovery of the first of these asteroids, so the close of the century

will be signalized in the history of astronomy by the detection among these little objects of one which has entirely cast into the shade all other discoveries of the same nature. On the night of the 13th of August, 1898, a German astronomer, Herr Witt, exposed a photographic plate to the heavens in his telescope in the Observatory of Urania, at Berlin. On that plate a picture of the heavens was obtained, and in that picture a new planet was revealed. At first the discovery of one more asteroid does not imply very much. Hundreds of such planets might be found, and indeed have been found, and yet no particular comment has been called forth. But this planet found by Witt is a unique object; it is more interesting than the whole of the four hundred and thirty-two other minor planets which have preceded it—not, indeed, on account of its size, for Witt's planet is a wholly insignificant object from this point of view. The special interest which this new planet has for us dwellers on the earth lies in the fact that it seems to be the nearest to the earth of all the other worlds in space—the moon, of course, excepted. This is the reason why the attention of all who are interested in the science of astronomy has been concentrated on Witt's discovery. It is certainly the most interesting telescopic revelation which has been made for many years.

It may illustrate a characteristic feature in the progress of modern astronomy if I describe how Witt succeeded in obtaining this picture. He had selected one of the most rapid plates that the skilled manufacturer can supply to the photographer. He put this plate into his telescope, and he directed it to the heavens. If that plate had been used in broad daylight for the more ordinary purpose of obtaining a photographic portrait, an exposure of half a second would have been quite long enough. But the very faint stars can not work their charm on the plate with equal rapidity; a second is not long enough, nor is ten seconds, nor even ten minutes. If we desire to secure an imprint of the faintest stars we must expose the plate for an hour, and sometimes for even much longer than an hour. Of course, an exposure of such duration would utterly ruin the picture if a gleam of any other light obtained access. But in the darkness of night the plate is secure from this danger. Each star is thus given time enough to impress its little image at leisure.

The photographer has often occasion to deplore the poorness of his light. It is, of course, in the endeavor to counteract the poorness of the light that so long an exposure is frequently given. But it will not be any longer supposed that, from the astronomer's point of view, a tedious exposure must necessarily be a disadvantage. Let it be henceforth recollected that it was the very require-

ment of a long exposure which led to the present important discovery. If the stars had been bright enough to be photographed by an exposure not longer than a few seconds or even than a few minutes, then this new and wonderful planet Eros would not have been revealed.

Many points of light which were undoubtedly stars, and merely stars, were shown on this picture taken by the German astronomer at Urania. Among these points of light was, however, one object which, though in appearance hardly distinguishable from a faint star, was in truth a body of a very different character. No telescope, however powerful, would show by mere inspection any appreciable difference between the dot of light indicating a star and the dot of light indicating the asteroid Eros. The fundamental difference between the star and Eros was, however, revealed by the long exposure. The stars in such a picture are, of course, at rest. They have occupied for years and for centuries the places where we now find them. If they are moving at all, their movements are so slow that they need not now be considered. But this starlike point, or, as we may at once call it, this asteroid, Eros, is moving. Not that its movements seem very rapid from the distance at which alone we are compelled to view it. No casual glance would indicate that Eros was flying along. The ordinary observer would see no change in its place in a second—no change in its place even in a minute. But when the exposure has lasted for an hour this asteroid, in the course of the hour, has moved quite appreciably. Hence arose a great difference between the representation which the photograph has given of the stars, properly so called, and of the asteroid. Each star is depicted as a sharp, well-defined point. This little body which is not a star, this unsteady sitter in the picture, could not be so represented; it merely appeared as a streak. The completed photograph accordingly shows a large number of well-marked dots for the stars, and among them one faint line for the asteroid.

Such a feature on a picture, though very unusual, does sometimes present itself. To detect such a streak on a photograph of the stars is a moment of transcendent joy to the astronomer. It is often for him the exciting occasion on which a discovery is made. This little moving point is in actual fact as different from a star as a pebble is different from a brilliant electric light. The resemblance of the asteroid to a star is merely casual; the resemblance would wholly disappear if we were able to make a closer inspection. The star is a brilliant blazing orb like a sun, but so far away that its luster is diminished to that of a point; the planet is comparatively near us; it is a dark body like our earth, and is like our

earth also in this further respect that all the light it enjoys has been derived from the sun.

Though there is this immense difference between a star and a planet, yet the observer must not expect to notice any such difference by merely taking a peep through the telescope. It was only the long exposure in the photograph that revealed the little body.

Such is the manner in which an asteroid is generally discovered in these latter days. A discovery like this comes as the well-earned reward of the skill and patience of the astronomical photographer. There are, indeed, a large number of known asteroids; our catalogues contained four hundred and thirty-two of them up to the time when Witt exposed his now famous plate. Had the asteroid Witt then found been merely as other asteroids, it would never have received the prominent position that has now to be assigned to it in any account of the astronomy of the century. That object found by Witt on this night which is to be henceforth memorable in astronomy is of a wholly exceptional kind. Had Eros been merely an ordinary asteroid, Witt might no doubt have received the credit to which his labors and success would have entitled him. Another asteroid would have been added to the long list of such objects already known, but the newspapers would never have troubled their readers about the matter, and the only persons who would have been affected would have been the astronomers, and perhaps even among them no particular sympathy would have been felt in certain quarters. Those particular astronomers to whom has been intrusted the special work of looking after the asteroids and of calculating the tables of their movements might even have received with no very great enthusiasm the announcement of this further addition to the burden on their heavily laden shoulders.

I have said that Eros is quite a small globe; it may be well for us fully to realize how small that asteroid actually is. If the moon were to be crushed into two million equal fragments, each of those parts would be as big as Eros. If the whole of Eros were to be covered with houses, the city thus formed would not be so large as greater London. So far as mere size is concerned, Eros is quite unimportant. We can further illustrate this if we compare Eros with some of the other planets. The well-known evening star, Venus, the goddess of love, is a hundred million times as big as that tiny orb we now call Eros, the god of love. After all this it may seem strange to have to maintain what is, however, undoubtedly the fact, that the discovery of Eros is one of the most remarkable discoveries of this century.

Until Eros was discovered, our nearest neighbors among the planets were considered to be Venus on one side and Mars on the

other. The other great planets are much more distant, while, of course, the stars properly so called are millions of times as far.

Great, then, was the astonishment of the astronomers when, by the discovery of Eros, Mars and Venus were suddenly dethroned from their position of being the earth's nearest neighbors among the planetary host. This little Eros will, under favorable circumstances, approach the earth to within about one third the distance of Mars when nearest, or about one half the distance of Venus when nearest. We thus concentrate on Eros all the interest which arises from the fact that, the moon of course excepted, Eros is the nearest globe to the earth in the wide expanse of heaven. To the astronomer this statement is of the utmost significance; when Eros comes so close it will be possible to determine its distance with a precision hitherto unattainable in such measurements. Once the distance of Eros is known, the distance of the sun and of all the other planets can be determined. The importance of the new discovery arises, then, from the fact that by the help of Eros all our measurements in the celestial spaces will gain that for which every astronomer strives—namely, increased accuracy.

Seeing that the existence of intelligence is a characteristic feature of this earth, we feel naturally very much interested in the question as to whether there can be intelligent beings dwelling on other worlds around us. It is only regrettable that our means of solving this problem are so inadequate. Indeed, until quite lately it would have been almost futile to discuss this question at all. All that could then have been said on the subject amounted to little more than the statement that it would be intolerable presumption for man to suppose that he alone, of all beings in the universe, was endowed with intelligence, and that his insignificant little earth, alone amid the myriad globes of space, enjoyed the distinction of being the abode of life. Recent discovery has, however, given a new aspect to this question. At the end of this century certain observations have been made disclosing features in the neighboring planet, Mars, which have riveted the attention of the world. On this question, above most others, extreme caution is necessary. It is especially the duty of the man of science to weigh carefully the evidence offered to him on a subject so important. He will test that evidence by every means in his power, and if he finds the evidence establishes certain conclusions, then he is bound to accept such conclusions irrespective of all other circumstances.

Mr. Percival Lowell has an observatory in an eminently favorable position at Flagstaff, in Arizona. He has a superb telescope, and enjoys a perfect climate for astronomical work. Aided by skillful assistants, he has observed Mars under the most favorable

circumstances with great care for some years. I must be permitted to say that, having carefully studied what Mr. Lowell has set forth, and having tested his facts and figures in every way in my power, most astronomers have come to the conclusion that, however astonishing his observations may seem to be, we can not refuse to accept them.

No one has ever seen inhabitants on Mars, but Mr. Percival Lowell and one or two other equally favored observers have seen features on that planet which, so far as our experience goes, can be explained in no other way than by supposing that they were made by an intelligent designer for an intelligent purpose. Mr. Lowell has discovered that there are certain operations in progress on the surface of Mars which, if we met with on this earth, we should certainly conclude, without the slightest hesitation, were the result of operations conducted under what we consider rational guidance.

A river, as Nature has made it, wends its way to and fro; it never takes the shortest route from one point to another; the width of the river is incessantly changing; sometimes it expands into a lake, sometimes it divides so as to inclose an island. If we could discern through our telescopes a winding line such as I have described on Mars it might perhaps represent a river.

But suppose, instead of a winding line, there was a perfectly straight line, or rather a great circle on the globe drawn as straight as a surveyor could lay it out—if we beheld an object like that on Mars I think we should certainly infer that it was not a river made in the ordinary course of natural operations; no natural river ever runs in that regular fashion. If such a straight line were indeed a river, then it must have been designedly straightened by human agency or by some other intelligent agency for some particular purpose. In its larger features Nature does not work by straight lines. A long and perfectly straight object, if found on our earth, might be a canal or it might be a road; it might be a railway or a terrace of some kind; but assuredly no one would expect it to be a natural object.

We have the testimony of Schiaparelli, now strengthened by that of Mr. Lowell and his assistants, that there are many straight lines of this kind on Mars. They appear to be just as straight as a railway would have to be if laid across the flat and boundless prairie, where the engineer encountered no obstacle whatever to make him swerve from the direct path. These lines on Mars run for hundreds of miles, sometimes, indeed, I should say for thousands of miles. They are far wider than any terrestrial river, except perhaps the Amazon for a short part of its course. The lines on Mars are about forty miles wide. Indeed, the planet is so distant

that if these lines were much narrower than forty miles they would be invisible. Each of them is marvelous in its uniformity throughout its entire length.

The existence of these straight lines on the planet contains perhaps the first suggestion of the presence of some intelligent beings on Mars. The mere occurrence of a number of perfectly straight, uniform lines on such a globe would in itself be a sufficiently remarkable circumstance. But there are other features exhibited by these objects which also suggest the astonishing surmise that they have been constructed by some intelligent beings for some intelligent purposes.

Sometimes two of these lines will start from a certain junction, sometimes there will be a third or a fourth from the same junction; in one case there are as many as seven radiating from the same point. Such an arrangement of these straight lines is certainly unlike anything that we find in Nature. We are led to seek for some other explanation of the phenomenon, and here is the explanation which Mr. Lowell offers:

It has recently been found that there are no oceans of water on the planet Mars. In earlier days it used no doubt to be believed that the dark marks easily seen in the telescope could represent nothing but oceans, but I think we must now give up the notion that these are watery expanses. Indeed, there is not much water on that globe anywhere in comparison with the abundance of water on our earth. It is the scarcity of water which seems to give a clew to some of the mysteries discovered on Mars by Schiaparelli and Lowell.

As our earth moves round the sun we have, of course, the changing seasons of the year. In a somewhat similar manner Mars revolves around the sun, and accordingly this planet has also its due succession of seasons. There is a summer on Mars, and there is a winter; during the winter on that globe the poles of the planet are much colder than at other seasons, and the water there accumulates in the form of ice or snow to make those ice-caps that telescopic observers have so long noticed. In this respect Mars, of course, is like our earth. The ice-cap at each pole of our globe is so vast that even the hottest summer does not suffice to melt the accumulation; much of the ice and snow there remains to form the eternal snow which every arctic explorer so well knows. It would seem, however, that the contrast between winter and summer on Mars must be much more deeply marked than the contrast between winter and summer on our earth. During the summer of Mars ice and snow vanish altogether from the poles of that planet.

Mr. Lowell supposes that water is so scarce on Mars that the

inhabitants have found it necessary to economize to the utmost whatever stock there may be of this most necessary element. The observations at Flagstaff tend to show that the dark lines on Mars mark the course of the canals by which the water melted in summer in the arctic regions is conducted over the globe to the tracts where the water is wanted. Not that the line as we see it represents actually the water itself; the straight line so characteristic of Mars's globe seems rather to correspond to the zones of vegetation which are brought into culture by means of water that flows along a canal in its center. In much the same way would the course of the Nile be exhibited to an inhabitant on Mars who was directing a telescope toward this earth: the river itself would not be visible, but the cultivated tracts which owe their fertility to the irrigation from the river would be broad enough to be distinguishable. The appearance of these irrigated zones would vary, of course, with the seasons; and we observe, as might have been expected, changes in the lines on Mars corresponding to the changes in the seasons of the planet.

A noteworthy development of astronomy in the last century has been the erection of mighty telescopes for the study of the heavens. It must here suffice to mention, as the latest and most remarkable of these, the famous instrument at the Yerkes Observatory, which belongs to the University of Chicago. Just as the century is drawing to its close, the Yerkes telescope has begun to enter on its sublime task of exhibiting the heavens under greater advantages than have ever been previously afforded to any astronomers since the world began.

The University of Chicago having been recently founded, it was desired to associate with the university an astronomical observatory which should be worthy of the astonishing place that this wonderful city has assumed in the world's history. Mr. Yerkes, an American millionaire, generously undertook to provide the cost of this observatory. Two noble disks of glass, forty inches in diameter, were produced at the furnaces of Messrs. Mantois, in Paris; these disks were worked by Mr. Alvan Clark, of Boston, into the famous object glass which, weighing nearly half a ton, has now been mounted in what we may describe as a temple or a palace such as had never been dreamed of before in the whole annals of astronomy.

Perhaps if we could now place the science of the nineteenth century in its proper perspective the most remarkable discovery which it contains would be that of the planet Neptune. Indeed, the whole annals of science present no incident of a more dramatic character.

It will be remembered that at the latter part of the eighteenth century William Herschel had immortalized himself by the discovery of a great planet, to which was presently assigned the name of Uranus. After the movements of Uranus had been carefully studied, it was found that on many previous occasions Uranus had been unwittingly observed by astronomers, who regarded it as a star. When these observations were all brought together, and when the track which Uranus followed through the heavens was thus opened to investigation, it was found that the movements of the planet presented considerable anomalies. The planet did not move precisely as it would have moved had it been subjected solely to the supreme attractive power of the sun. Astronomers are, of course, accustomed to irregularities of this description in the movements of the planets. These irregularities have as their origin the attractions of the various other members of the solar system. It is possible to submit these attractions to calculation and thus to estimate their amount. The effect, for instance, of Saturn in disturbing Jupiter can be allowed for, and the nature of Jupiter's motion as thus modified can be precisely estimated. In like manner, the influence of the earth on Venus can be determined, and so for the other planets; and thus, generally speaking, it was found that when the proper allowances had been made for the action of known causes of disturbance, then the calculated movement of each planet could be reconciled with observation.

The circumstances of Uranus were, however, in this respect wholly exceptional. Due allowance was first made for the attraction of Uranus by Saturn, and for the attraction of Uranus by Jupiter, as well as by the other planets. It was thus found that the irregularities of Uranus could be to some extent explained, but that it was not possible in this manner to account for those irregularities completely. It was therefore evident that some influence must be at work affecting the movement of Uranus, in addition to those arising from any planet of which astronomers hitherto had cognizance. The only available supposition would be that some other planet, at present unrecognized, must be in our system, and that the attraction of this unknown body must give rise to those irregularities of Uranus which remained still outstanding.

A great problem was thus proposed for mathematicians. It was nothing less than to affect the determination of the orbit and the position of this unknown planet, the sole guide to the solution of the problem being afforded by the discrepancies between the places of Uranus as actually observed and the places which were indicated by the calculations, when every allowance had been made for known causes. The problem was indeed a difficult one, but,

fortunately, two mathematicians proved to be equal to the task of solving it—Adams, in England, and Le Verrier, in France. Each of these astronomers, in independence of the other, succeeded in determining the place of the planet in the sky. The dramatic incident of this discovery was afforded when the mathematicians had done their work. When the place of the planet had been ascertained, then the telescopic search was undertaken to verify if it were indeed the case that a planet hitherto unknown did actually lurk in the spot to which the calculations pointed. Every one who has ever read a book on astronomy is well acquainted with the wonderful manner in which this verification was made. Just where the mathematicians indicated, there was the great planet discovered! To this object the name of "Neptune" has been assigned, and its discovery may be said to mark an epoch in the history of gravitation. It provided a most striking illustration of the truth of those great laws which Newton had discovered.

The latter half of the century will be also remarkable in the history of science from the fact that within that period mankind has been enabled to make some acquaintance with the chemistry of the celestial bodies. It was in 1859 that Kirchhoff and Bunsen first expounded to the world the true meaning of the dark lines in the solar spectrum. In this they were following out a line of reasoning that had been previously suggested by Prof. Sir G. Stokes, of Cambridge, England. Those who are at all conversant with that wonderful branch of knowledge known as spectrum analysis are aware how these discoveries have rendered it possible for us to determine in many cases the actual material elements found in the most distant bodies.

One of the striking results to which this investigation has led is the demonstration of the substantial unity of the materials from which the earth and the various heavenly bodies have been constructed. Those elements which enter most abundantly into the composition of the earth are also the elements which appear to enter most abundantly into the composition of the sun and of the stars. The iron and the hydrogen, the sodium and the many other materials of which our globe is so largely formed, are also the selfsame materials which, in widely different proportions and in very different associations, go to form the heavenly bodies. This conclusion is as interesting as it was unexpected. It might naturally have been thought that, seeing the sun is separated from us by nearly a hundred million miles, and seeing that the stars are separated from us by millions of millions of miles, all these celestial bodies must be constructed in quite a different manner and of substances quite distinct from the substances which we know

on this earth. But this is not the case. Indeed, at the present moment it seems doubtful if there be any element which spectrum analysis has hitherto disclosed in the celestial bodies which is not also a recognized terrestrial body. The well-known case of helium gives a striking illustration. In the year 1868 Sir Norman Lockyer detected the presence of rays in the solar spectrum which were unknown at that time in terrestrial chemistry. These rays appeared to emanate from some substance which, though present in the sun, did not then appear to belong to the earth. This element was accordingly named "helium," to indicate its solar origin. Twenty-five years later Professor Ramsay discovered a substance on the earth which had been hitherto unrecognized, and which, on examination, yielded in the spectrum precisely those same rays which had been found in the so-called helium from the sun. In consequence of this discovery this element is now recognized as a terrestrial body. It is indeed a remarkable illustration of the extraordinary character of modern methods of research that a substance should have first been discovered at a distance of nearly one hundred million miles, that same substance being all the time, though no doubt in very small quantities, a constituent of our earth as well as of the sun.

Much has been done within the past century in many other branches of astronomy. I must especially mention the important subject of meteoric showers. For the development of our knowledge of this attractive part of astronomy we are largely indebted to the labors of the late Prof. H. Newton, of Yale. By his investigations, in conjunction with those of the late Professor Adams, it was demonstrated that the shower of shooting stars which usually appears in the middle of November is derived from a shoal of small bodies which revolve around the sun in an elliptic track, and accomplish that circuit in about thirty-three years and a quarter. The earth crosses the track of these meteors in the middle of November. If it should happen that the great shoal is passing through the junction at the time the earth also arrives there, then the earth rushes through the shoal of little bodies. These plunge into our atmosphere, they are ignited by the friction, and a great shower is observed. It is thus that we account for the recurrence of specially superb displays at intervals of about thirty-three years.

But one more great astronomical discovery of this century must be mentioned, and here again, as in so many other instances, we are indebted to American astronomers. It was in 1877 that Prof. Asaph Hall discovered that the planet Mars was attended by two satellites. This was indeed a great achievement, and excited the liveliest interest and attention. Since the days when

telescopes were first invented all the astronomers have been looking at Mars, and yet they never noticed (their telescopes were not good enough) those interesting satellites which the acute observation of Professor Hall detected with the help of the great telescope of the Naval Observatory at Washington. This discovery was followed by another of a still more delicate nature, when that consummate observer, Professor Barnard, using the great Lick telescope, detected the fifth satellite of Jupiter. This is indeed a most difficult object to observe, requiring, as it does, the highest optical power, the most perfect atmospheric conditions, and the most skillful of astronomical observers. We may take this observation to represent the high-water mark of telescopic astronomy in the nineteenth century. This being so, it may fitly conclude this brief account of some of the most remarkable astronomical discoveries which that century has produced.

THE APPLICATIONS OF EXPLOSIVES.

By CHARLES E. MUNROE,
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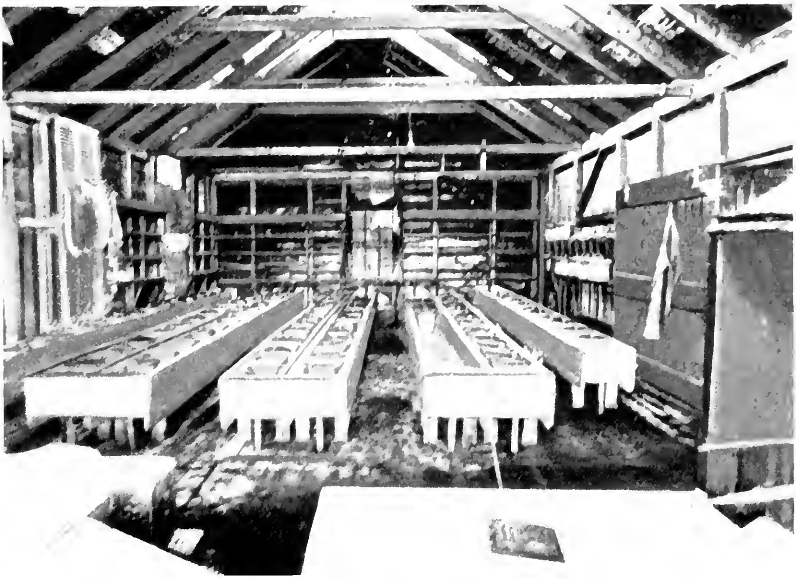
THERE is something about fire which fascinates every one, yet the action of explosives arouses even a livelier interest, since the accompanying fiery phenomena are more intense and are attended with a shocking report and a violent destruction of the surrounding material, while this train of events, with all its marked

GUN COTTON FACTORY. Dipping cotton in nitrating troughs.

effects, is set in operation by what appears to be a very slight initial cause. It is evident on brief consideration that these bodies, like a coiled spring, a bent bow, or a head of water, are enormous reservoirs of energy which can be released at a touch, and which, if



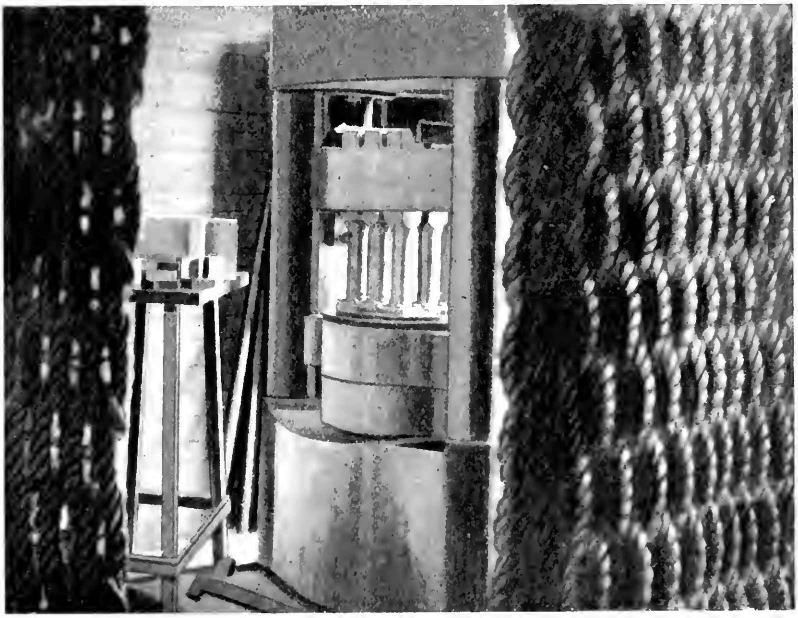
Gun-Cotton Factory. Digestion troughs.

the explosive be properly placed in well-proportioned amounts and discharged at the right time, can be made to do useful and important work that can not be as conveniently and quickly accomplished in most cases, and in some cases can not be accomplished at all by any other means.

The marked characteristic of all explosive substances, and especially of the so-called high explosives, is that the energy, as developed, is at high potential, and the uses to which energy in this condition can be economically put are so manifold that the production of explosives has become one of the most important of our chemical industries, this country alone producing, in 1890, 108,735,980 pounds, having a value of nearly $11,000,000.

The number of possible substances possessing explosive properties is exceedingly large; the number actually known is so great that it has taxed the ingenuity of inventors to provide them with suitable names; but these various explosive substances vary to so great an extent in the energy they will develop in practice and in their safety in storage, transportation, and use that but a comparatively small number have met with wide acceptance. All may be

classified under the heads of physical mixtures like gunpowder, or chemical compounds like nitroglycerin, and they owe their development of energy to the fact that, like gunpowder, they are mixtures in which combustible substances such as charcoal are mixed with supporters of combustion such as niter; or that, like chloride of nitrogen, they are chemical compounds, the formation of whose molecules is attended with the absorption of heat; or that, like gun cotton, they are chemical compounds whose molecules contain both the combustible and the supporter of combustion, and whose formation from their elements is attended with the absorption of heat; while occupying a middle place between the gunpowder and the

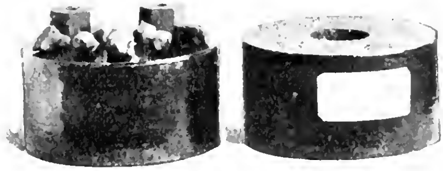


Gun-Cotton Factory. Final press.

gun-cotton class, and possessing also to some degree the properties of the nitrogen-chloride class, are the nitro-substitution explosives, of which melinite, emmensite, lyddite, and joveite furnish conspicuous examples.

It may lead to a clearer understanding of what is said regarding the applications of explosives to dwell briefly on the methods by which some of them are produced, since, although the raw material in each case is different and the details of the operations vary, the underlying principles of the methods are the same, and a good example is found in the military gun cotton as made by the Abel process at the United States Naval Torpedo Station.

The material employed is cotton, but whether fresh from the field or in the form of waste, it must first be freed from dirt by hand picking and sorting, and from grease and incrusting substances by boiling in a weak soda solution. The cotton is now dried by wringing in a centrifugal wringer and exposing to a current of hot air in a metal closet; but as the compacted mass of cotton holds moisture with great persistency, after partial drying the cotton is passed through a cotton picker to open the fiber, so that it not only yields its contained water more readily and completely, but it also absorbs the acids more speedily in the dipping process to which it is subsequently exposed.



Gunpowder Grains. The large ones are over five pounds weight, each.

When the moisture, by the final drying, is reduced to one half of one per cent the cotton is, while hot, placed in copper tanks which close hermetically, where it cools to the atmospheric temperature and in which it is transported to the dipping room, where a battery of large iron troughs, filled with a mixture of one part of the most concentrated nitric acid and three parts of the most concentrated sulphuric acid, set in a large iron water bath to keep the mixture at a uniform temperature, is placed under a hood against the wall. The fluffy cotton, in one-pound lots, is dipped handful by handful under the acid, by means of an iron fork, where it is allowed to remain for ten minutes, when it is raised to the grating at the rear of the trough and squeezed with the lever press to remove the excess of acid. It still retains about ten pounds of the acid mixture, and in this condition is placed in an acid-proof stoneware crock, where it is squeezed by another iron press to cause the contained acid to rise above the surface of the partly converted

Burning Disk of Gun Cotton.

Extinguishing burning Gun Cotton.

cotton. The covered crock is now placed with others in wooden troughs containing running water so as to keep the temperature uniform, where the cotton is allowed to digest for about twenty-four hours. The acid is then wrung out in a steel centrifugal, and the wrung gun cotton is thrown in small lots into an immersion tank containing a large volume of flowing water, in which a paddle wheel is revolving so as to rapidly dilute and wash away the residual

MAKING MERCURY FULMINATE.

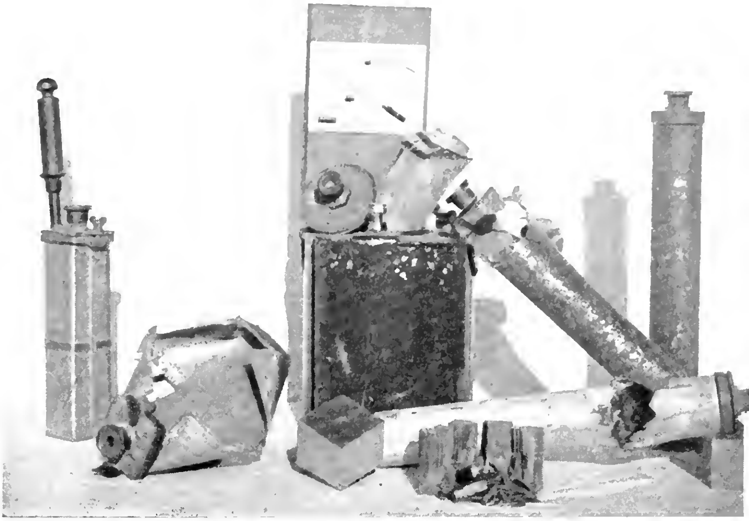
acid in the gun cotton without permitting any considerable rise of temperature from the reaction of the water with the acid.

Even these severe means are not enough, for, as the cotton fiber is in the form of hairlike tubes, traces of the acid sufficient to bring about the subsequent decomposition of the gun cotton are retained by capillarity. Therefore, after boiling with a dilute solution of sodium carbonate, the gun cotton is pulped and washed in a beater or rag engine until the fiber is reduced to the fineness of corn meal, and a sample of it will pass the "heat test." This is a test of the resistance of gun cotton to decomposition, and requires that when the air-dried sample of gun cotton is heated to 65.5° C. in a closed tube in which a moistened strip of potassium iodide and starch paper is suspended, the paper should not become discolored in less than fifteen minutes' exposure.

DETONATOR USED IN THE UNITED STATES NAVY.
Contains thirty-five grains of fulminate of mercury.

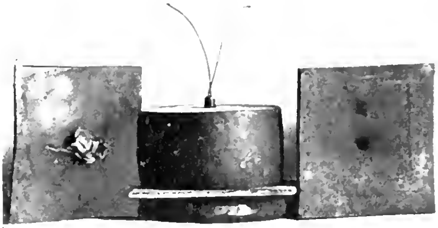
This pulping of the gun cotton not only enables one to more

completely purify it, but it also renders it possible to mold it into convenient forms and to compress it so as to greatly increase its efficiency in use. For this purpose the pulp is suspended in water



Torpedo Cases and Blocks of Wood destroyed by a Naval Detonator.

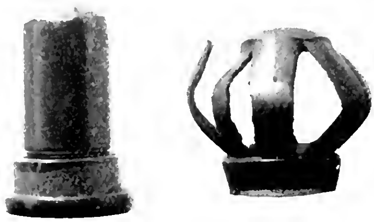
and pumped to a molding press, where, under a hydraulic pressure of one hundred pounds to the square inch, it is molded into cylinders or prisms about three inches in diameter and five inches and a half high, and these are compressed to two inches in height by a final press exerting a pressure of about sixty-eight hundred pounds to the square inch. As this is regarded as a somewhat hazardous operation, the press is surrounded by a mantlet woven from stout rope to protect the workmen from flying pieces of metal in case of an accident. The operation is analogous to that employed in powder-making, where the gunpowder has been pressed in a great variety of forms and into single grains weighing several pounds apiece.



Testing Detonators on Iron Plates.

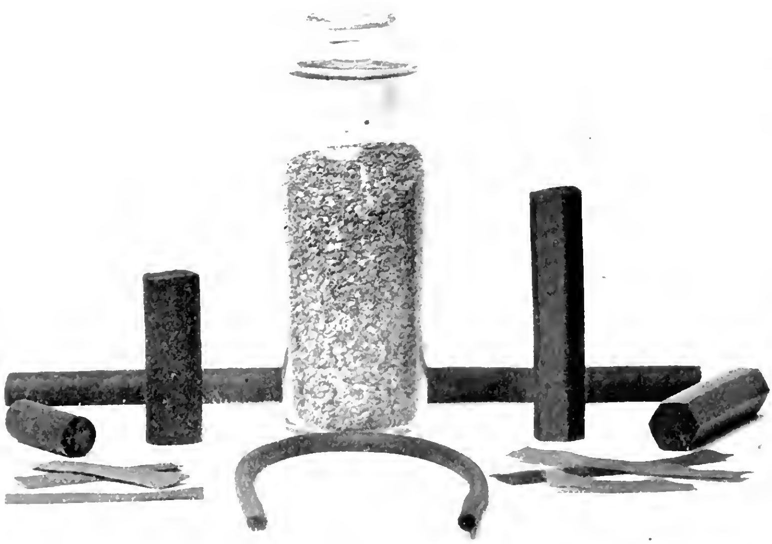
Even under the enormous pressure of the final press the compressed gun cotton still retains from twelve to sixteen per cent of water, and in this form it is quite safe to store and handle. When dry it is very combustible and burns readily

when ignited, but it can be quenched by pouring water upon it. When confined in the chamber of a gun or the bore-hole of a rock, gun cotton will burn like gunpowder when ignited, if dry, and produce an explosion, but, in common with nitroglycerin and other high explosives, gun cotton is best exploded and develops its maximum effect when detonated, a result which is secured by exploding a small quantity of mercury fulminate in contact with the dry material.



Iron Cylinder filled with Water and containing a Naval Detonator. Before and after firing, shows the work accomplished by thirty-five grains of mercury fulminate.

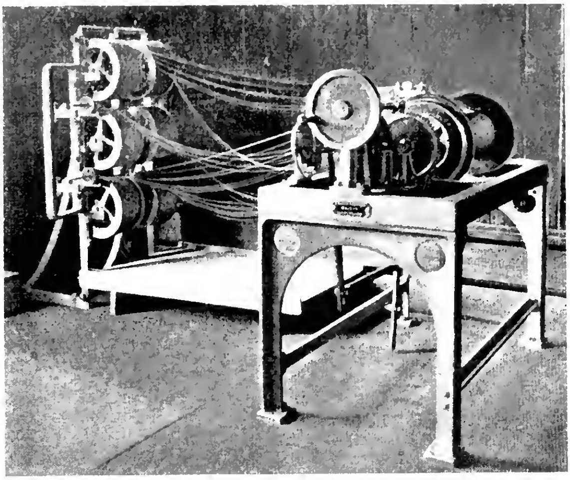
Mercury fulminate is made by dissolving mercury in nitric acid and pouring the solution thus produced into alcohol, when a violent reaction takes place and the fulminate is deposited as a crystalline gray powder. This powder is loaded in copper cases and, after drying, it is primed with dry-mealed



Smokeless Powders. In the bottle is indurite in flake grains. The larger grains are cylindrical and hexagonal multiperforated United States army grains. The bent grain in the foreground, looking like a piece of rubber tubing, is a grain of Maxim powder with a single canal. The flat strips in the foreground on the left are grains of the French B. N. powder. The flat strips in the foreground on the right are grains of the United States navy "pyrocellulose" powder.

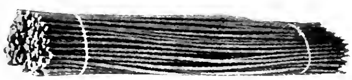
gun cotton, the mouth of the case being closed with a sulphur-glass plug, through which pass two copper leading wires joined by a bridge of platinum-iridium wire, two one-thousandths of an inch in diame-

ter, which becomes heated to incandescence when an electric current is sent through it. This device is what is known as the naval detonator. Mercury fulminate is so employed because it is the most vio-



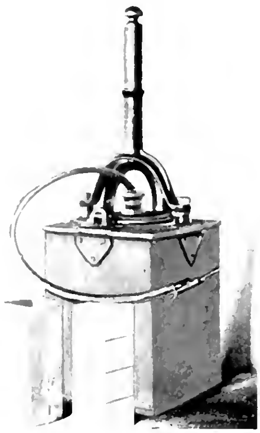
Blending Machine for Cordite.

lent of all explosives in common use, and exerts a pressure of forty-eight thousand atmospheres when fired in contact. Although the naval detonator contains but thirty-five grains of mercury fulminate, yet it will rupture stout iron and heavy tin torpedo cases when fired suspended in them, it will rend thick blocks of wood when placed in a hole and fired within them, and it will even pierce holes through plates of the finest wrought iron one-sixteenth inch in thickness if only the base of the detonator is in contact with the plate, and this has been used as a test of their efficiency. Its force is markedly shown by firing one in a stout iron cylinder filled with water and closed tightly, when the cylinder is blown into a shredded sphere. When used to detonate gun cotton, either when confined or in the open, the detonator is placed in the hole which has been molded in the center of the gun-cotton disk or block, so that it shall be in close contact with the gun cotton. I have found that perfectly dry compressed gun cotton is detonated by 2.83 grains of mercury fulminate; but as a torpedo attack is necessarily in the nature of a forlorn hope and should be provided with every possible provision against failure, and since if the detonator fails the attack fails, the naval detonator is supplied with thirty-five grains, so as to give a large coefficient of assurance.



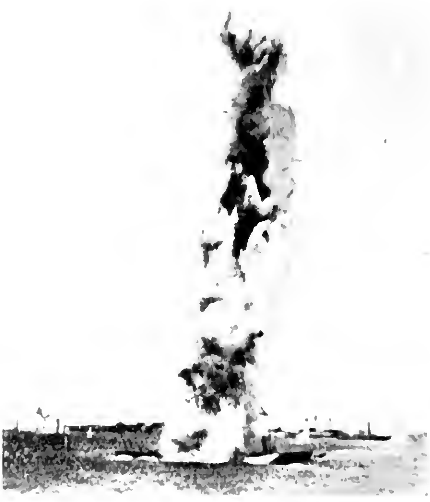
Cartridge of Cordite Smokeless Powder. Charge for 6-inch 2 F gun, 13 pounds, 4 ounces. Cords, $22\frac{3}{4}$ inches long, 3 inches in diameter.

A characteristic feature of gun cotton is that it may be detonated even when completely saturated with and immersed in water, if only some dry gun cotton be detonated in contact with it. Thus in one experiment a disk of dry gun cotton was covered with a water-proof coating and the detonator inserted in the detonator hole of this disk. This dry disk was laid upon four uncoated disks, the five lashed tightly together, and sunk in Newport Harbor, where the column remained until the uncoated disks were saturated with salt water, when the mine was fired and the saturated disks were found by measurement of the work done to have been completely exploded. I have found that three ounces of dry compressed gun cotton will cause the detonation of wet compressed gun cotton in contact with it, but forty ounces of dry gun cotton are used as the primer in our naval mines and torpedoes, so as to give a large coefficient of assurance.



GUN COTTON SPAR TORPEDO.

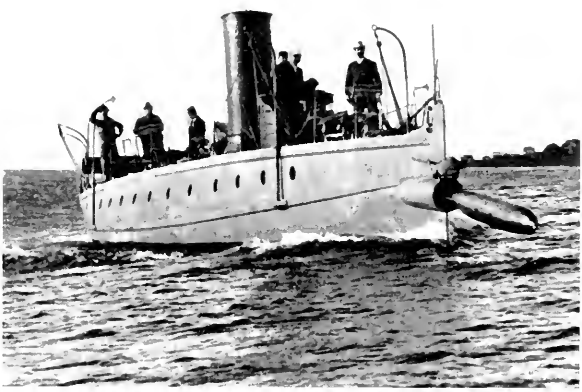
In the mining and other industries the fulminate is used in smaller quantities and it is generally mixed with potassium chlorate, the mixture being compressed in small copper cases and sold as blasting caps. They are fired by means of a piece of Bickford or running fuse, consisting of a woven cotton or hemp tube containing a core of gunpowder, which is inserted in the mouth of the copper cap and made fast within it by crimping. The capped fuse is then inserted in a dynamite cartridge so that the cap is firmly in contact with the dynamite, the mouth of the cartridge is fastened securely, and the charge inserted in the bore-hole in the rock and tamped. The protruding end of the fuse is lighted, and the fire travels at the rate of three feet per minute



BLOWING UP THE SCHOONER JOSEPH HENRY.

down the train of gunpowder to the fulminate, which then detonates and causes the detonation of the dynamite.

Although gun cotton, nitroglycerin, and their congeners can be and usually are fired by detonation, there has within recent years been a great number of compositions invented which, while formed from gun cotton alone or mixtures of it with nitroglycerin, burn progressively when ignited and are therefore available for use as propellants; and since the products of their burning are almost wholly gaseous, they produce but little or no smoke and are therefore called smokeless powders. As upward of fifty-seven per cent of the products of the burning of ordinary gunpowder are solids or easily compressed vapors, this comparative smokelessness of the modern powders is a very important characteristic, and



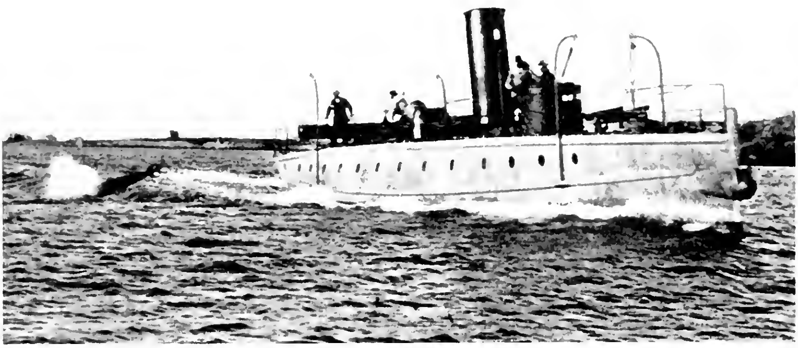
TORPEDO PRACTICE. Bow discharge.

when used in battle they seriously modify our former accepted methods of handling troops. While this is the feature of these powders which has attracted popular attention, a far more important quality which they possess is the power to impart to a projectile a much higher velocity than black powder does, without exerting an undue pressure on the gun. A velocity of over twenty-four hundred feet per second has been imparted to a one-hundred-pound projectile with the powder that I have invented for our navy, while the pressure on the gun was less than fifteen tons to the square inch.

Prior to my work in this field all the so-called smokeless powders were mixtures of several ingredients, resembling gunpowder in this respect. But, considering the precise and difficult work that was expected of these high-powered powders and the difficulty

which had always been found in securing uniformity in mixtures, and that this difficulty had become the more apparent as the gun became more highly developed, I sought to produce a powder which should consist of a single chemical substance in a state of chemical purity, and which could be formed into grains of such form and size as were most suitable for the piece in which the powder was to be used.

I succeeded in so treating cellulose nitrate of the highest degree of nitration as to convert it into a mass like ivory and yet leave it pure. In this indurated condition the gun cotton will burn freely, but it has not been possible to detonate it even when closely confined and exposed to the initial detonation of large masses of mercury fulminate.



Torpedo Practice on the Cushing. Broadside discharge.

I am happy to say that this principle has now been adopted by the Russian Government, and by our navy in its specifications for smokeless powder; but they have, I think unwisely, selected a cellulose nitrate containing 12.5 per cent or less of nitrogen instead of that of the highest nitration.

This work was completed, a factory established, and the processes well marked out when I left the torpedo station in 1892. Besides this, there were then already commercial works established elsewhere in this country for the manufacture of the nitroglycerin-nitrocellulose powders of the ballistite class, while large quantities of many varieties could be easily procured abroad. Considering these facts, and that France and Germany had already adopted smokeless powders in 1887, that Italy adopted one in 1888, and England about the same time, it is unpardonable that our services should not yet have adopted any of the smokeless powders available when we were drawn into the conflict with Spain.

Besides their use as ballistic agents, gun cotton, dynamite, and explosive gelatin in their ordinary condition have found employment and been adopted as service explosives in military and naval mining, as their great energy and the violence with which they

LAUNCHING PATRICK TORPEDO FROM THE WAYS.

explode, even when unconfined, especially adapt them for use in the various kinds of torpedoes and mines which are in vogue in the service.

One form of these torpedoes was attached to the end of a spar or pole which was rigged out from the bow of a launch or vessel so that it could be thrust under the enemy's vessel, and the detonators of such spar torpedoes were not only connected with electric generators, so that they could be fired at will, but they, in common with mines, were frequently provided with a system of levers so arranged that the enemy's vessel fired the torpedoes and mines automatically as it came in contact with the levers. It was with such a contact-spar torpedo, containing thirty-three

PATRICK TORPEDO UNDER WAY. Moving at the rate of twenty-three knots per hour.

pounds of gun cotton, that the schooner Joseph Henry was blown up in Newport Harbor in 1884.

There are many types of the automobile torpedo. Among them the Hall, Patrick, Whitehead, and Howell may be cited.

The first three are propelled by the energy resident in compressed gases; the Howell by the energy stored in a heavy fly wheel, which also, by acting on the gyroscopic principle, serves to maintain the direction imparted to the torpedo as it is launched. The Hall, Whitehead, and Howell are launched from tubes or guns by means of light powder charges, and are independent of exterior control after launching. The Patrick is launched from ways, and is controlled from the shore or boat by a wire through which an electric current may be sent to its steering mechanism. The charges are quite variable, but the war heads of the larger torpedoes contain as much as five hundred pounds of gun cotton.

[*To be concluded.*]

A PARADOXICAL ANARCHIST.

By Prof. CESARE LOMBROSO.

WHILE I have had the privilege of making several indirect studies of anarchists by means of the data furnished by legal processes, the journals, and the handwriting of the subjects, I have only rarely been able to examine one directly and make those measurements and craniological determinations upon him without which any study can be only approximate, or, we might even say, hypothetical. I had, however, an opportunity a short time ago to observe a real anarchist in person, and study him according to the methods of my criminological clinic. The results have been singular, and it seems to me that they should cast some light upon the dark world of these agitators, and especially upon the phenomena of the strange contradictions presented in their life; manifestations which jurists and police officers, intent only on achieving the judicial triumph of a conviction, consider and call simulations and falsehoods.

He was a fellow who had caused a great excitement, during the crowded days of the exposition at Turin, by saying that he wanted to kill the king. In fact, he gave himself up to the police, saying that the anarchists of Alexandria were seeking the assassination of the king, and had written him a letter directing him to arm himself, but that he, wishing anything else than to commit regicide, had surrendered in order to denounce the scheme. There was no real basis of criminal intent, but our police put him in prison, and there I found him.

His physiognomy presented all the characteristics of the born criminal and of the foolhardy and sanguinary anarchist. He had

flaring ears, premature and deep wrinkles, small, sinister eyes sunk back in their orbits, a hollowed flat nose, and small beard—in short, he presented an extraordinary resemblance to Ravachol, as may be seen from their portraits.

The cranium was a little smaller than the normal, and the upper part of the skull was much rounded and deformed, with a cephalic index of 91—considerably more rounded than the head of Luccheni. The horizontal fold of the hand was of a type much like that of Ravachol.

I add that the biological study, which was made directly, and therefore more satisfactorily than was practicable with Caserio and Luccheni, revealed a series of very singular anomalies; a touch six times more obtuse than the normal—six millimetres on the right, five on the left; a remarkably blunt sensitiveness to pain and dull perception of location; an extraordinarily reduced visual field, particularly in the left eye; a somewhat tremulous handwriting, and slight defects of articulation in speech; and thin hair. There was nothing very striking in his affective nature. He spoke kindly of his parents, whom he would be glad to see. But he had a blunt moral sense, and had committed frequent thefts, especially against his family, so that he had been put into a house of correction. And it was just while he was still in this establishment, at sixteen years of age, that he pretended to have been invited to attend a meeting of about thirty anarchists at Brescia, where he was made to swear, kissing a dagger, to kill the king. He described the room, and spoke of the individual persons present, and then said that he thought no more of the matter after he returned to the house; but a few days ago it had come into his mind to go to the post office, and there he had found a letter from the anarchists of Alexandria, urging him to arm himself to kill the king.

He repeated this story minutely and with great persistence, notwithstanding the postal authorities denied having given him the letter, in the face of the asseverations of the prefects that there were not thirty anarchists in Brescia, where he was in correction, and although all the facts were against him. Observe that he was in prison, that he had been there three months, and that he was told he would be likely to stay there as long as he adhered to his story.

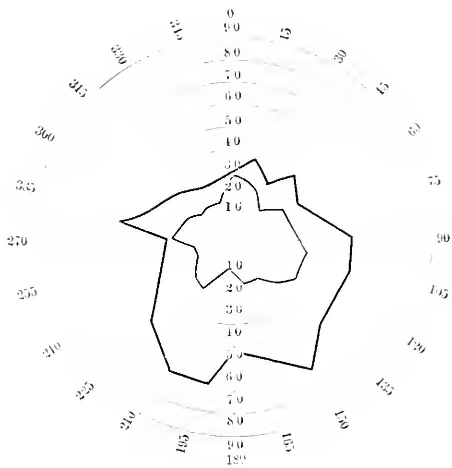
Efforts to account for the phenomenon were unsuccessful, because his friends and relatives made no mention of any traces of insanity. Light began to break upon the case when it was learned that he had attempted suicide, a few years before, in grief at the death of his mother, and also that on the day before he gave himself up he had stolen a small sum from his drunken brother. These, however, were only distant hints. The matter was fully explained when, after he had drunk a litre of wine in the prison, he began to exclaim, "*Viva l'anarchio!*" (Hurrah for anarchy!), "*Morte al Re!*" (Death to the king!), to kiss a dagger, to break various things against imaginary guards, and, after a short period of quiet, to swear and forswear himself that his companions had done what he had done, that they had shouted for anarchy, had broken the vases, and had desired to kill the king.

Ravachol.

This cleared up the matter at once for me, but I wished to complete the elucidation with an experiment. I began by giving him ten, then twenty, then thirty, then forty grammes of alcohol, up to eighty. I observed that his personality began to change after forty grammes. He became somewhat insolent and suspicious, and had vague delirious imaginings of persecutions. When invited to sing anarchistic songs he refused, evidently fearing to compromise himself, but sang them voluntarily in an undertone. When the dose of alcohol was increased to ninety grammes his personality seemed immediately to undergo a full change; his touch became twice as fine (three millimetres), and his visual field increased threefold; he declared that there was a spy around. When put into his cell he sang anarchistic hymns, threatened death to

the king, handled a box as if brandishing a dagger, climbed to a window and insulted the sentinel, resisted five men who tried to disarm him, and continued in this condition for eight hours.

The next day he denied having done any of these things, avowed that he was a good monarchist and a good citizen, and declared distinctly that he had not done what he had done, in the face of the concurrent testimony of several witnesses. On renewing the experiment a few days afterward with eighty grammes of alcohol, the same series of phenomena recurred — a real anarchistic raving, a genuine mania for regicide, which would certainly have ended in some act if he had not been restrained by force; and this person, who had at first presented an evident obtusity of touch and an extraordinary contraction of the visual field, now exhibited an almost normal touch of three millimetres and a visual field enlarged to triple its extent when he was sober.



VISUAL FIELD (LEFT EYE) OF CHIE . . . GIAC . . .
The line ———— indicates the normal visual field (left eye).
The line ———— indicates the visual field (left eye) under alcoholic excitement.

On the day after this he recollected none of all the things that had happened the day before. This double personality was determined in him by alcohol, as it is in others by misery or by fanaticism, while it rests with all upon a congenital basis. The fact helps us to explain how some inoffensive man may have a type of physiognomy quite similar to that of Ravachol, showing how often there are true criminals in potency, whose physiognomy, or rather the anomalies of it, bears a prophetic relation to the crime which breaks out on the first determining circumstance. And we have here another explanation of such contradictory characters as those of Ravachol, Caserio, and Luccheni, who, having been once well-behaved, end by becoming criminals.

APPLIED science was defined by Sir W. Roberts Austen, in his presidential address to the Iron and Steel Institute, 1899, as "nothing but the application of pure science to particular classes of problems."

WHAT MAKES THE TROLLEY CAR GO.

By WILLIAM BAXTER, Jr., C. E.

I.

Of all the wonderful operations accomplished by the aid of electricity at the present time, none so completely mystifies the beholder as the action of the trolley car. The electric light, although incomprehensible to the average layman, does not excite his curiosity to the same extent. The glowing filament of an incandescent lamp or the dazzling carbon points of an arc light stimulate the inquisitive proclivities to some extent, but as the popular notion with respect to the nature of electricity is that it is some kind of fluid that can flow through wires and other things like water through a pipe, the conclusion arrived at is that the current, in its passage through the filament or the carbon points, generates a sufficient amount of heat to raise the temperature of the material to the luminous point. The fact that energy is required to raise the temperature of the mass to the incandescent point is not taken into consideration by those not versed in technical matters, owing to the fact that, as nothing moves, it is not supposed that power can be expended. When a trolley car is seen coming down the street at a high rate of speed the effect upon the mind is very different. Here we see a vast amount of weight propelled at a high velocity, and yet the only source through which the power to accomplish this result is supplied is a small wire. The mystifying cause does not stop here, for if we look further into the matter we see that the energy has to pass from the trolley wire to the car through the very small contact between it and the trolley wheel. After contemplating these facts, it appears remarkable that the energy that can creep through this diminutive passage can by any means be made to develop the force necessary to propel a car with a heavy load up a steep grade. An electrical engineer, if asked to explain the action, would say that the force of magnetic attraction was made use of to accomplish the result, but this explanation would fail to throw any light upon the subject. In what follows, it is proposed to explain the matter in a simple manner, and then it will be seen that what appears to be an incomprehensible mystery, when not understood, is, in fact, no mystery at all.

Electricity and magnetism are two forces that are intimately associated with each other, and, although radically different, it is

Note.—The illustrations of railway motor, generator, and switchboard (Figs. 15, 16, 17) were made from photographs kindly furnished by the manufacturers, the Westinghouse Electric and Manufacturing Company.

difficult, if not impossible, to obtain one without the other, although it is a simple matter to make one inactive under certain conditions. It is very generally understood that a magnet possesses the power of attraction, and that it will draw toward it pieces of iron, steel, and other magnets. The laws governing the attractive properties of magnets, however, are not so well understood, and many are not aware of the fact that under certain conditions one magnet will repel another, but such is nevertheless the case.

In Fig. 1 the lower outline, *M*, represents a magnet fixed in position, and the upper bar represents another magnet arranged to swing freely around the pivot *a*. A magnet, as is generally known, will arrange itself in a north-to-south position if suspended from its center, like a scale beam, and allowed to swing freely, and the same end will always point toward the north. On this account the ends of a magnet are called its poles, and the one that will point toward the north is designated the north pole, while the other one is the south pole. The terms north and south poles were applied to magnets centuries ago, but at the present time the ends are more commonly designated as positive and negative. In Fig. 1 it will be noticed that the stationary magnet has its positive end upward, and this attracts the negative end of the swinging magnet. If the order of the poles is reversed, so that the positive of the swinging magnet will come opposite the positive of the stationary one, then there will be a repulsive action instead of an attraction, as is shown in Fig. 2. If the two negative ends were placed opposite, the effect would be the same. From this we see that to obtain an attraction we must place the magnets so that opposite poles come together, and that by reversing the order we obtain a repulsive action.

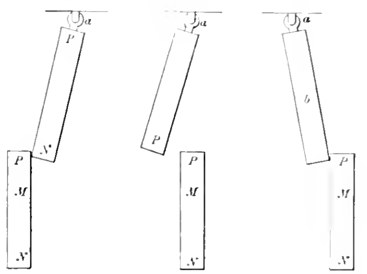


Fig. 1. Fig. 2. Fig. 3.

FIGS. 1, 2, 3.—DIAGRAMS ILLUSTRATING THE ATTRACTION AND REPULSION OF MAGNETS.

If the swinging magnet is replaced by a bar of iron, as is shown in Fig. 3, there will be an attraction, no matter what end of the magnet may be uppermost, thus showing that either end of a magnet will attract a bar of iron. The explanation of these different actions is that when two magnets are brought into proximity to each other each one exerts its force without any regard to the other, and if the two are set to act together they will attract one another, but if set to act in opposition they will repel. When one of the bars is not a magnet, but simply a piece of iron or steel,

this bar, having no attractive or repulsive force of its own, can only obey the attractive action of the other, which is the only one that exerts a force.

In Fig. 4 M is a magnet bent into the form of a U, commonly called a horseshoe magnet. The short bar set between the upper ends is also a magnet, and is arranged so as to revolve around the shaft s. From what has just been explained in connection with Figs. 1 and 2 it will be understood that, with the poles as indicated by the letters, there will be an attractive force set up between the top end of the straight bar and the P end of the horseshoe, and thus rotation will be produced in the direction of the arrow. The rotation, however, will necessarily stop when the bar reaches the position shown in Fig. 5, for then the attraction between the poles will resist further movement. If the straight bar were not a magnet, but simply a piece of iron or steel, it is evident that when in the position of Fig. 4 the attraction would be just as much toward the right as toward the left, and if the bar were placed accurately in the central position it would not swing in either direction. It would be in the condition called, in mechanics, unstable equilibrium. In practice this condition could not be very well realized, as it would be difficult to set and retain the bar in a position where the attraction from both sides would be the same, therefore the rotation would be in one direction or the other; but whichever way the bar might move, it would only swing through one quarter of a revolution, into the horizontal position of Fig. 5.

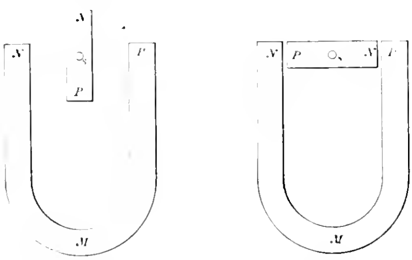


Fig. 4. Fig. 5.

FIGS. 4, 5.—DIAGRAMS ILLUSTRATING THE METHOD OF OBTAINING ROTARY MOTION WITH MAGNETS.

If we reflect upon these actions we can see that if we could destroy the magnetism of both parts before the straight bar reaches the position of Fig. 5 it would be possible to obtain rotation through a greater distance than one quarter of a turn, for then the headway acquired by the rotating part would cause it to continue its motion. If, after the completion of one half of a revolution, we could remagnetize both parts, we would then set up an attraction between the lower end of the straight bar and the left side of the horseshoe, for then the polarity of the former would be the reverse of that shown in Fig. 4—that is, the lower end would be negative. By means of this second attraction we would cause the bar to rotate through the third quarter of the revolution, and if, just before

completing this last quarter, we were to remove all the magnetism again, the headway would keep up the motion through the final quarter of the revolution, thus completing one full turn. From this it will be realized that if we could magnetize and demagnetize the two parts twice in each revolution a continuous rotation could be obtained.

If the magnetizing and demagnetizing action were only applied to the rotating part we would fail to keep up a continuous rotation, for, as was shown in connection with Fig. 3, the action when the straight bar reached the position of Fig. 5 would be the same as if it were magnetized, owing to the fact that a magnet always exerts an attraction upon a mass of iron. Suppose, however, that we were to reverse the polarity of the rotating part just as it reaches the position of Fig. 5, then there would be two poles of the same polarity opposite each other, and, as shown in Fig. 2, the force acting between them would be repulsive, and would push the bar around in the direction of rotation. Not only would the right-side pole of the horseshoe force the end of the bar away from it, but the negative pole, on the left side, would attract this same end, and thus a force would be exerted by the two poles of *M* to keep up the rotation through the next half of a circle. On reaching this last position the rotation would stop if the polarity of the revolving bar were left unchanged, for then the poles facing each other would be of opposite polarity. If, however, we again reversed the polarity, a repulsion would be set up between the poles facing each other, and thus a force would be exerted to continue the rotation. Thus we see that if the polarity of the horseshoe magnet is not disturbed it is necessary to reverse that of the rotating part to obtain a continuous motion, but if we change the magnetic conditions of both parts, then it is only necessary to magnetize and demagnetize them alternately.

From the foregoing it is seen that there are two ways in which the force of magnetism could be utilized to keep up a continuous rotation, and the question now is, Can either of them be made available in practice? To this we answer that, by the aid of the relations existing between electricity and magnetism, both can be and are made available, as will be shown in the following paragraphs:

In Fig. 6 *W* represents a coil of wire provided with a cotton covering, so that there may be no actual contact between the adjoining convolutions. If the ends *p n* of this coil are connected with a source of electric energy, an electric current will flow through it, and if a bar, as indicated by *N P*, of iron or steel is placed within the coil it will become magnetized. If the bar is

made of steel and is hardened it will retain the magnetism, and become what is called a permanent magnet: such a magnet, in fact, as we have considered in all the previous figures. If the bar is made of iron it will not retain the magnetism, but will only be a magnet as long as the electric current flows through the coil W. A magnet of the latter type is called an electro-magnet. If the iron is of poor quality—that is, from an electrical standpoint—it will require an appreciable time to lose its magnetism, but if it is soft and high grade, electrically considered, it will lose its magnetism instantly, or nearly so. If we take two bars of soft iron and arrange them side by side, as in Fig. 7, and wind coils around them as indicated each one will become magnetized when the ends p n of the coils are connected with an electric circuit. If the lower ends of the two bars are joined by a piece, as shown at M, we will have a horseshoe electro-magnet. If we take a round disk of iron, as in Fig. 8, and wind a coil around it, it will also become a magnet when an electric current traverses the coil. Thus it will be seen that it makes little difference what the shape of the iron may be, providing it is surrounded by a coil of wire and an electric current is passed through the latter. This being the case, it is evident that either of the processes explained in connection with Figs. 4 and 5 can be made available for the production of a continuous rotation by the aid of electro-magnets. Suppose we make a drum, as shown in Fig. 9, and wind a wire coil around it in the direction indicated, then when a current passes through the wire the drum will be magnetized, with poles at top and bottom. If the electric current passes through the wire from end p to end n the drum will be magnetized positively at the top and negatively at the bottom, and if the direction of the current through the wire is reversed the polarity of the drum will be reversed. If we construct a horseshoe magnet of the shape shown in Fig. 10, and place within the circular opening between its ends the drum of Fig. 9, we will have a device that is capable of developing a continuous rotation, providing we have suitable means for reversing the direction of the electric current through the wire coil; and this machine constitutes an electric motor in its simplest form.

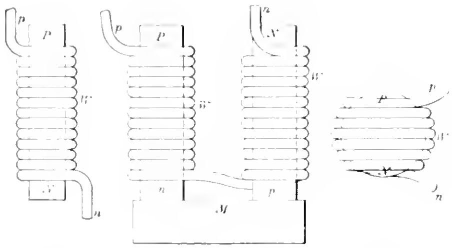


Fig. 6. Fig. 7. Fig. 8.

Figs. 6, 7, 8.—Diagrams illustrating the Principles of Electro-Magnets.

In an electric motor the horseshoe magnet is called the field

magnet, and the rotating part is called the armature, while the device by means of which the direction of the current through the armature coil is reversed is called the commutator. In this last figure it will be noticed that the coils wound upon the field magnet are represented as of wire much finer than that wound upon the armature. In actual practice machines are sometimes wound in this way, and sometimes the field wire is twice as large as that on the armature. When the field wire is very much finer than that of the armature the machine is what is known as shunt wound, which means that only a small portion of the current that passed through the armature passes through the field coils. Although with this type of winding the current that passes through the field coils is very weak, the magnetism developed thereby can be made greater than that of the armature if desired. This result is accomplished by increasing the number of turns of wire in the field coils. Thus if the current through the armature is one hundred times as strong as that through the field coils, the latter can be made to equal the effect of the former by increasing the number of turns in the proportion of one hundred to one, and if the increase is still greater the field coils will develop the strongest magnetism. The reason why a small current passing around a magnet a great many times

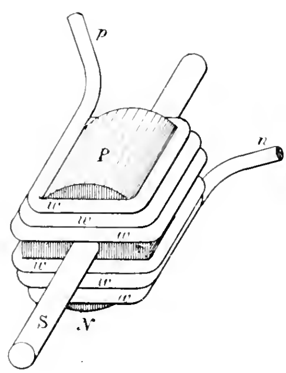


Fig. 9.

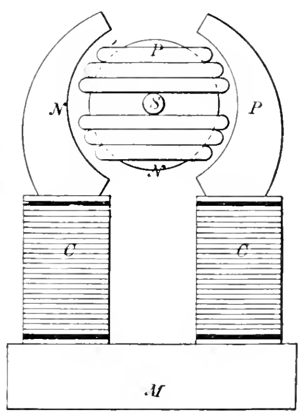


Fig. 10.

Figs. 9, 10.—Diagrams illustrating the Principles of the Electric Motor.

will develop as strong a magnetization as a large current, can be readily understood when we say that the magnetism is in proportion to the total strength of the electric current that circulates around the magnet. Suppose we have two currents, one of which is one thousand times as strong as the other, then if the weak one is passed through a coil consisting of one thousand turns it will develop just as strong a magnetization as the large current passing

through a coil of only one turn. This last explanation enables us to see how it is that the comparatively small current that can pass through the contact between the trolley wire and the trolley wheel can develop in the motor force sufficient to propel a heavy car up a steep grade. When that small current reaches the car motors it passes through a thousand or more turns of wire, and thus its effect is increased a corresponding number of times.

A motor having a single coil of wire upon the armature, as in Fig. 10, would not give very satisfactory results, owing to the fact that the rotative force developed by it would not be uniform. Such motors are made in very small sizes, but never when a machine of any capacity is required. For large machines it is necessary to wind the armature with a number of coils, so that the rotating force may be uniform, and also so that the current may be reversed by the commutator without producing sparks so large as to destroy the device. When an armature is wound with a number of coils the direction of the current is reversed, by the commutator, in each coil as it reaches the point where its usefulness ends, and where, if it continued to flow in the same direction, it would act to hold the armature back. The effect of this reversal of the current in one coil after another is to maintain the polarity of the armature practically at the same point, so that the strongest pull is exerted between it and the field magnet poles at all times. To explain clearly the way in which the commutator reverses the current in one coil at a time it will be necessary to make use of a diagram illustrating what is called a ring armature. Such a diagram is shown in Fig. 11. The ring *A* is the armature core, and is made of iron; the wire coils are represented as consisting of one turn to each coil, and are marked *w w w*. The current enters the wire through the spring *B*, and passes out through *C*. As can be seen, the current from *B* can flow through the coils *w w* in both directions, thus dividing into two currents, each one of which will traverse one half of the wire wound upon the armature. The two half currents will meet at *C*. If the armature is rotated the springs *B* and *C* (which are called commutator brushes) will pass from one turn of the wire coil to another just back of it as the rotation progresses, and each time that contact is made with a new turn the direction of the current in the turn just ahead will be reversed. The current in the wire as a whole, however, will always be in the same direction—that is, in all the turns to the right of the two brushes; the current will flow toward the center of the shaft on the front side of the armature, and away from the shaft in all the turns on the left side. As the direction of the current on opposite sides of the brushes is always the same, the poles

of the armature will remain under *B* and *C*, therefore the relation between the position of the poles of the armature and the field magnet will be the same substantially as that illustrated in Fig. 10, and, as a result, the force tending to produce rotation will at all times be the greatest possible for the strength of the current used and the size of the magnets.

Armatures are wound with a number of turns of wire in each coil, unless the machine is very large, and present an appearance more like Fig. 12. In this figure the brushes are arranged to make contact with the outer surface of the ring *C*, which is the commutator. The segments *s s* are connected with the ends of the armature coils *c c c*, but are separated from each other by some kind of material that will not conduct electricity—that is, they are electrically insulated. As will be noticed from this, the armature

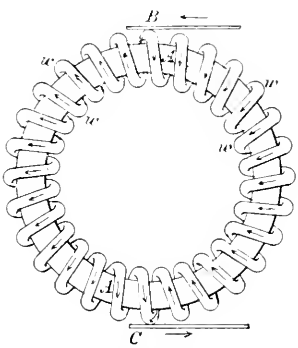


Fig. 11.

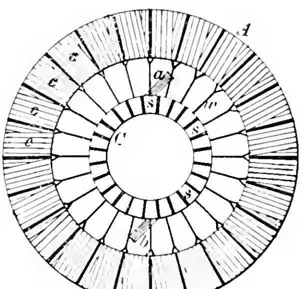


Fig. 12.

Figs. 11, 12.—Diagrams illustrating the Method of winding Armatures of Electric Motors and Generators.

in Fig. 11 acts as a commutator as well as an armature, its outer surface performing the former office. In the winding the difference between Figs. 11 and 12 is simply in the number of turns in each coil, there being one turn in Fig. 11 and several in Fig. 12.

The armature shown in Fig. 10 is of the type called drum armature, but it can be wound so as to produce the same result as the ring, although it is not so easy to explain this style of winding. It will be sufficient for the present explanation to say that whatever type of armature may be used, the winding is always such that the direction of the current through the wire coils is reversed progressively, so that the magnetic polarity is maintained practically at the same point; therefore there is a continuous pull between this point of the armature core and the poles of the field magnet. The commutator is secured to the armature shaft, and the brushes

through which the current enters and leaves are held stationary; keeping this fact in mind, it can be seen at once that in Fig. 12 the current will flow from the brush *a* through the two sides of the armature wire to brush *b*, hence all the coils on the right of the vertical line will be traversed by the current in the same direction—that is, either to or from the center of the shaft—and in the coils on the left the direction will be opposite, which is just the same order as was explained in connection with Fig. 11.

An electric motor can be turned into an electric generator by simply reversing the direction in which the armature rotates—that is, any electric machine is either a generator or a motor. This fact can be illustrated by means of Figs. 13 and 14, both of which show the armature and the poles of the field magnet. The first figure represents an electric motor, and, as can be seen, the pull between the *N* pole of the armature and the *P* pole of the field is in the direction of arrow *b*, hence the armature will rotate in the same direction, as indicated by arrow *a*. To obtain the polarity of the armature and field it is necessary to pass an electric current through both—that is to say, we must expend electrical energy to obtain power from the machine. As soon as the current ceases to flow, the polarity of the armature and field dies out, and the rotation of the former comes to an end. The magnetism, however, does not die out entirely; a small residue is always left, although it is never sufficient to produce rotation, and even if it were it could only cause the armature to revolve through one quarter of a turn. If, after the current has been shut off, the armature shaft is rotated in the reverse direction, as indicated by arrow *a* in Fig. 14, the motion will be against the pull of the magnetism; therefore, although the poles may be very weak, an amount of power sufficient to overcome their attraction must be applied to the pulley, otherwise rotation can not be accomplished. In consequence of the backward rotation a current is generated in the armature coils, and this current, as it traverses the field coils as well as those of the armature, causes the polarity of both parts to increase. As a result of the increased polarity the resistance to rotation is increased, and more power has to be applied to the pulley. The increase in the strength of the poles results in increasing the current generated, and this in turn further increases the pole strength, so that one effect helps the other, the result being

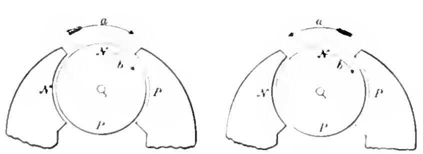


Fig. 13. Fig. 14.

Figs 13, 14.—Diagrams illustrating the Difference between an Electric Motor and a Generator.

that the current, which starts with an infinitesimal strength, soon rises to the maximum capacity of the machine.

The motor shown in Fig. 10 does not in any way resemble an electric railway motor, nevertheless the principle of action is precisely the same in both. The design of a machine of any kind has to conform to the practical requirements, and this is true of railway motors, just as it is true of printing presses, sawmills, or any other mechanism. A railway motor must be designed to run at

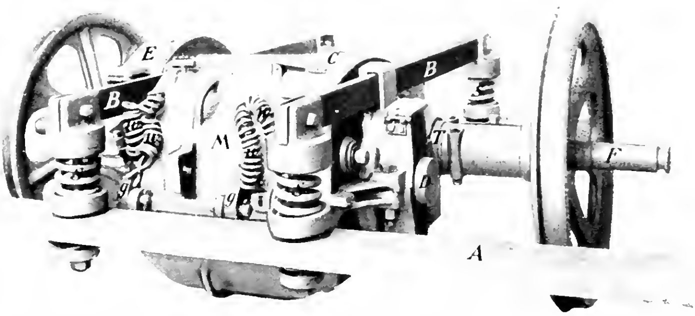


FIG. 15.—EXTERNAL VIEW OF ELECTRIC RAILWAY MOTOR MOUNTED UPON CAR-WHEEL AXLE.

a comparatively slow speed and to develop a strong rotative force, or torque, as it is technically called. It must also be so constructed that it will not be injured if covered with mud and water. It must be compact, strong, and light, and capable of withstanding a severe strain without giving out. To render the machine water- and mud-proof it is formed with an outer iron shell, which entirely incases the internal parts. The first railway motors were not inclosed, and the result was that they frequently came to grief from the effects of a shower of mud. When the modern inclosed type of motor, which is called the iron-clad type, first made its appearance it was frequently spoken of as the clam-shell type, and the name is not altogether inappropriate, for while the outside may be covered with mud to such an extent as to entirely obliterate the design, the interior will remain perfectly clean and dry, and therefore its effectiveness will not be impaired.

To enable the motor to give a strong torque and run at a slow speed the number of poles in the field and armature is increased. The design of Fig. 10 has two poles in the field and two in the armature, and is what is known as the bipolar type. Machines having more than two poles in each part are called multipolar machines. The number of poles can be increased by pairs, but not by a single pole—that is, we can have four, six, eight, or any other even number of poles, but not five, seven, or any odd number. This is owing to the fact that there must always be

as many positive as negative poles, no more and no less. Railway motors at the present time are made with four poles. The external appearance can be understood from Fig. 15, while Fig. 16 and Fig. 17 will serve to elucidate the internal construction. In Fig. 15 the motor casing is marked *M*, and, as will be seen, it forms a complete shell. The motion of the armature shaft is transmitted to the car-wheel axle *F* through a pinion, which engages with a spur gear secured to the latter. In Fig. 16 the pinion and gear are marked *N* and *L* respectively. As it is necessary that the armature shaft and the axle be kept in perfect alignment, the motor casing *M* is provided with suitable bearings for both, those for the armature shaft being marked *P P* in Fig. 16, and one of those for the axle being marked *T* in Fig. 15. It will be understood from the foregoing that the motor is mounted so as to swing around the car-wheel axle as a center, but, as it is not desirable to have all this dead weight resting upon the wheels without any elasticity, the motor is carried by the crossbars *B B*, Fig. 15, which rest upon springs *s s* at each end. The beam *A* and a similar one at the farther end of the *B B* bars extend out to the sides of the car truck and are suitably secured to the latter. The coils *w w* are the ends of the field coils and the armature connections, and to these

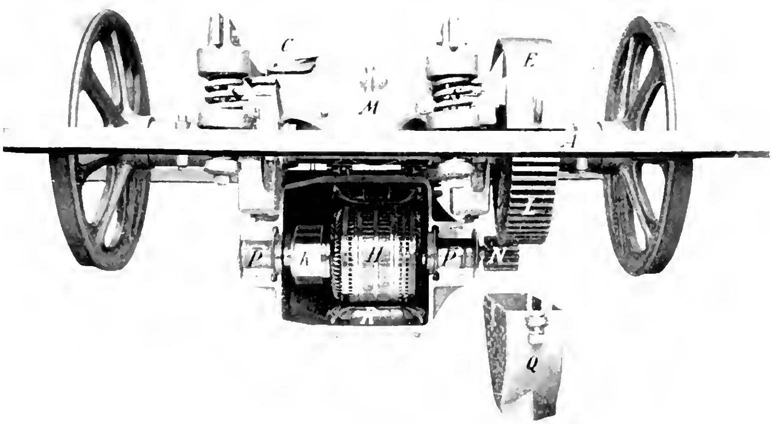


FIG. 16.—RAILWAY MOTOR WITH CASING OPEN, SHOWING ARMATURE IN LOWER HALF.

the wires conveying the current from the trolley are connected. The cover *C* on top of the motor at one end closes an opening through which access to the commutator brushes is obtained. The armature is shown at *H* in Fig. 16 and the commutator at *K* in the same figure. Directly under the armature may be seen one of the field magnet coils, it being marked *R*.

As will be noticed in Fig. 16, the motor casing is made so as to open along the central line, and the lower half is secured to the

top by means of hinges, *g g*, Fig. 15, and also by a number of bolts, which are not so clearly shown. The gear wheels are also located within a casing, which (Fig. 16) is made so as to be readily opened whenever it becomes necessary. All the vital parts of the machine are entirely covered, and are not easily injured by mud or water.

The construction of the armature and commutator is well illustrated in Fig. 17, which shows this part of the machine by itself. The armature is marked *A*, the shaft *B*, and the commutator *C*. In the diagrams, Figs. 9, 10, 11, and 12, the wire coils are represented as wound upon the surface of the armature core, but, from Fig. 17, it will be noticed that they are located in grooves. A railway motor armature core, when seen without the wire coils, looks very much like a wide-faced cog wheel with extra long teeth, not very well shaped for gear teeth. In Fig. 17 the ends of the teeth are marked *D*, and the grooves within which the wire is wound are marked *E*. The coils are not wound so that their sides are on diametrically opposite sides of the armature core, but so that they may be one quarter of the circumference apart, and, as will be noticed, the wires are arranged so as to fit neatly into each other at the ends of the armature core. The bands marked *F F F F* are provided for the purpose of holding the wire coils within the grooves. The flanges *H* and *I* are simply shields to prevent oil, grease, or even water, if it should pass through the bearings, from being thrown upon the commutator or armature. The pinion through which the armature imparts motion to the car-wheel axle is not shown in Fig. 17, but it is mounted upon the taper end of the shaft.

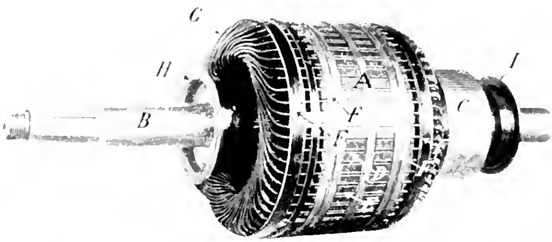


Fig. 17.—Armature of Electric Railway Motor.

An electric railway motor is a machine that is characterized by extreme simplicity (there being only one moving part), compactness, and great strength. In addition, as none of the working parts is exposed it can not be injured, no matter how much mud may accumulate upon it. One of the reasons why the electric railway motor has met with such unparalleled success is that it is a machine that can withstand the roughest kind of usage without being damaged thereby. Another reason is that an electric motor can, if called upon, develop an amount of power two or three times greater than its

full-rated capacity without injury, providing the strain is not maintained too long. A steam engine or any other type of motor that has ever been used for railway propulsion if loaded beyond its capacity will come to a standstill—that is, it will be stalled—but an electric motor can not be stalled with any strain that is likely to be placed upon it. If the load is increased the motor will run slower and the current will become greater, thus increasing the pull, but the armature will continue to rotate until the current becomes so great as to burn out the insulation. A railway motor calculated to work up to twenty-five-horse power will have to develop on an average about six- or seven-horse power, but if the car runs off the track on a steep grade, and has such a heavy load that the motor is called upon to develop one-hundred-horse power for a few seconds, the machine will be equal to the occasion. This result a steam, gas, or any other type of engine can not accomplish, and it is this fact as much as anything else that has given the electric motor the control of the street-railway field.

[*To be continued.*]

WOMAN'S STRUGGLE FOR LIBERTY IN GERMANY.

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IT is during the latter part of the present century that a general movement has arisen to give women their rights in business life and in political and social affairs. It is the intention of this article to treat of this movement, especially in its relation to education, in Germany, where, of all civilized lands, it has had apparently the smallest results. Progress in the direction indicated has been, however, far greater than appears on the surface, and the movement is slowly taking shape in a form that will gain official recognition and support, and the way is being prepared for scholarly attainments among the women of Germany, superior, possibly, to those of the women of other nations.

There is, moreover, an ideal side to this movement in Germany not altogether found in other lands. The motive for advanced study is more largely joy in the study itself, and desire to supply the spiritual needs of an idle life. In order to understand this ideal tendency it is necessary to cast a glance backward over nearly three hundred years.

Let us begin with the contest which was waged so successfully for the development and protection of the German language, first

against the Latin and later against the French. In this struggle women took a prominent part, especially through membership in the society called the "Order of the Palms," which, before the beginning of the Thirty Years' War, united the strongest spirits of Germany for this purpose. The first woman to join this society was Sophie Elizabeth, Princess of Mecklenburg, married in 1636 to the Herzog of Braunschweig. She was followed by many others, both of the nobility and the common people, and was named by virtue of this leadership "The Deliverer."

In the eighteenth century we have the founder of the German theater, Caroline Neuber. In the artistic sense she was the first director of the German stage, the first to turn the attention of the greatest actors of her day to the ideal side of dramatic presentation. Early in the eighteenth century women began to take up university studies. A certain Frau von Zingler received a prize from the University of Wittenberg for literary work, and the wife of Professor Gottscheds entered upon a contest for a prize in poetry with her husband.

We find some old verses published in Leipsic, in a book of students' songs, in 1736, recognizing the fact that women attended lectures in the university there, although the reference is rather sarcastic, speaking of "beauty coming to listen in the halls of learning."

In 1754 the first woman received her degree of Doctor of Medicine in Halle—Dorothea Christine Erxleben, *née* Leborin, a daughter of a physician, who attained to this result only after many years of painstaking effort. With her father's help she studied the classics and medicine, and gradually, in spite of the objections of his brother physicians, began to practice as a doctor under her father's protection. She is said to have cured her patients *cito tuto, jucunde,* and in 1742 she published a book on the right of women to study, the title of which, according to the custom of the day, included the full table of contents. This book passed through two editions, and enabled her to gain the attention of Frederick II, who was persuaded to order the University of Halle to grant her the privilege of taking her examination there. The day arrived, and the hall was crowded for the occasion; the candidate passed the ordeal in a brilliant manner, and took the oath for the doctor's degree amid a storm of applause from the listeners present.

In the present century the germ of the movement for educational rights for women came into consciousness in Germany in the stormy year 1848, and first found expression and life through the work of two women—Louise Otto Peters and Auguste Schmidt.

The former founded the Universal Association for Women in Germany, and through this society both these women worked for thirty years and did much toward preparing the way for the broader efforts of the present time.

It is a fact granted by all the educational world that scholarship attains a depth and thoroughness in Germany not found in other lands, and this very perfection has been in part the cause of the backwardness of the educational movement among the women, for a high degree of scholarship has often been acquired by the men at the expense of the devoted service of the women connected with them. Yet when the women of Germany demand their educational rights it will be to share also in the rich intellectual inheritance of their land.

The majority of the men thus far regard the movement with distrust and suspicion, but are powerless to crush it out. An amusing instance occurred last year in the family of an official in one of the large university towns. He was a conservative man who had his immediate family in a proper state of subjection, but his mother-in-law, alas! he could not control, and to his dismay she enrolled herself at the university as a *Hospitant*, and, in spite of the protestations of her son-in-law, she was a regular attendant upon the courses of lectures that she had elected.

The regular schools for girls in Germany, above the common schools attended by girls and boys together, are of two grades—the middle schools and the high schools. The avowed object of these schools is to fit girls for society and for the position of housewife, as Herr Dr. Bosse, the Minister of Public Instruction for the German Empire, states in his report on the condition of girls' schools in Germany, and as he publicly declared before the German Parliament in the discussion regarding the establishment of a girls' gymnasium in Breslau, referred to later on in this paper.

The girls' schools established by the Government provide well for the study of the modern languages, and it is the exception to find women in the upper classes who do not speak French and English. Literature, religion, gymnastics, and needlework are also well taught. The course of study in the high school includes a little mathematics, offered under the name of reckoning, and sufficient to enable a woman to keep the accounts of a household, and also a little science of the kind that can be learned without a knowledge of mathematics. Let me quote a paragraph from the report of the Minister of Public Instruction for the year 1898 in regard to the aim of the mathematical course in the girls' high schools: "Accuracy in reckoning with numbers and the ability to use num-

bers in the common relations of life, especially in housekeeping. Great weight is laid upon quick mental computations, but in all grades the choice of problems should be such as especially apply to the keeping of a house." This is the opportunity which is offered to girls by the Government in the department of mathematics! In addition to the two grades of schools mentioned there are seminaries in many of the large cities for the purpose of educating women teachers. The instructors in these seminaries are well prepared for their positions, are mostly men, and the instruction given is very superior to that given in the girls' high schools. Latin and Greek are, however, not studied in these seminaries, and mathematics and science are expurgated, we might say, of points that might prove difficult for the feminine intellect.

The ability to learn Latin and Greek seems in the German mind to especially mark the dividing line between the masculine and feminine brain. The writer was at one time studying a subject in Greek philosophy, in the City Library of Munich, requiring the use of a number of Greek and Latin books, and it was amusing to notice the astonishment of the men present that a woman should know the classic languages!

The women who hold certificates from the seminaries are allowed, according to a new law passed in 1894, to continue their studies and to take the higher teachers' examinations. This is considered a great step in advance, for a woman who has successfully passed this latter examination can hold any position in the girls' schools, and can even be director of such a school.

That German women have long been discontented with the education provided for them by the Government is proved by the fact that the number of higher institutions offering private opportunities to girls is constantly increasing. As far back as 1868 the Victoria Lyceum was founded by a Scotch woman—Miss Georgina Archer—at her own expense and on her own responsibility, and this institution was well sustained from the beginning. It is now under the patronage of the Empress Frederick, and offers courses to women that run parallel to a certain extent with those given on the same subjects in the university. Professors from the university lecture in the Victoria Lyceum, but a young woman who had listened to the same professor in both places informed me that he (perhaps unconsciously) simplified his lectures very much for the Victoria Lyceum. Fraulein Anna von Cotta is the director of the institution. Among the women who teach there we note the name of the well-known Fraulein Lange, who lectures on psychology and German literature.

There are several girls' gymnasia in Germany which testify to

the demand for higher education. These institutions are all but one private, and three of them—one in Leipsic, one in Berlin, and a third, opened in October, 1898, in Königsberg—are called "gymnasial courses," and are for girls who have finished the girls' high school, and who must pass entrance examinations in order to be received into them.

There has been for some time a girls' gymnasium which corresponds exactly to those for boys in Carlsruhe, under the auspices of the "Society for Reform in the Education of Women," which receives girls of twelve who must have finished the six lower classes of a girls' school. This society, to which the girls of Germany owe much, is planning to open another gymnasium in Hannover, to which girls will be received from the junior class of the girls' high school; the course of study will occupy five years, and will fit girls for the same official examinations as the boys' gymnasia. The language courses in the highest class will be elective, providing either for Greek or the modern languages, but Latin is obligatory in all the classes. The girls from all these gymnasia are debarred from taking any of the official examinations for which their studies have prepared them.

The next step in the matter of gymnasial education for girls was what might have been expected. The people of the wide-awake city of Breslau voted, by an overwhelming majority, to establish a girls' gymnasium under the same laws and furnishing the same advantages as the boys' gymnasia. The completed plan was sent to the Minister of Public Instruction in Berlin in January, 1898, for approval, with the intention of opening the gymnasium at Easter, for which twenty-six girls were already enrolled. Herr Dr. Bosse, however, foreseeing the results such an undertaking would involve, consulted the other departments of the ministry, and two months later a decided refusal came like a thunderbolt upon the people of Breslau. On the 30th of April, 1898, Herr Dr. Bosse was called to account in the Reichstag for his action in the matter, which he justified on the ground that Government approval of girls' gymnasia would mean the acceptance of the diploma for matriculation in the universities and the opening to women of all Government professional examinations, and that to have granted it would have been to take a step in the direction of the modern movement for women which could never have been recalled, and would open the lecture rooms of Germany in general to women. He contended, further, that the founding of official gymnasia for girls would delegate the existing girls' high school to a secondary place, an institution which had been planned thoughtfully by the Government for the purpose of educating

women in the best manner, not to become rivals of men, but helpmeets and able housekeepers.

The demand of the people of Breslau, Dr. Bosse said, was an unnatural one, and his refusal was founded on the fear that such a movement would increase and threaten the social foundations of all Germany, as the idea that women can compete with men in all careers is a false one.

The petition of the magistrate of Breslau was supported in the discussion by some of the national-liberal, free-conservative, and Polish representatives. These took the broad ground that girls have a right to equal education with boys, and that the educational institutions of Germany which have so long stood at the head of those of the world should not, in the matter of education of women, leave the question to be decided according to the whims of private individuals.

Some of the arguments of those who spoke in favor of the enterprise were amusing. One said that the girls of Germany would be grateful if the Minister of Public Instruction would furnish them with husbands, but, as there were not enough to go around, the others should have some career provided for them. Another, that about forty per cent of the girls of the higher classes no longer marry, and they should not be allowed to suffer the consequences of the fact that young men of the present day do not care to marry, but they have a right that the way be shown them to such careers as are suited to their feminine nature.

An objector said that he could not understand how any man of pedagogical culture could approve of a girls' gymnasium, for it is evident that any such progress for women as that would imply must be at the expense of the men, who would gain less on account of the increased number of candidates for work of all kinds and would more seldom be able to offer the best of all existences to a woman—that of wifehood. The city of Breslau was obliged, therefore, to give up the undertaking for the present, but the agitation of the question has probably prepared the way for more extended plans in the future in the same direction in Prussia.

A similar undertaking in Carlsruhe, in Baden, has met with better success, and resulted in the opening of the first official gymnasium for girls in Germany, in September, 1898. This gymnasium was planned about the same time as that of Breslau, and as the permission of the Minister of Public Instruction in Baden was obtained without difficulty, the institution came into existence according to the will of the people of Carlsruhe. Seventy-nine of the members of the Bürgerauschuss voted in favor of the undertaking in the meeting in which the final action was taken early

in the summer of 1898. The Christian-conservative party only decidedly opposed it. The leader of this party was very much excited over the matter, and called out, when the action was taken, "I ask you, gentlemen, on your honor, if any of you would marry a girl from a gymnasium?"

The opening of the Government gymnasium will remove the necessity for continuing the private one in Carlsruhe, under the society in charge of it, and leave that society free to direct its efforts elsewhere.

There had already been several references to the general subject of the education of women in the Reichstag before the question of the gymnasium in Breslau came up. In January, 1898, Prince Carolath spoke in favor of founding several girls' gymnasia, and admitting women legally to the universities and to pedagogical and to medical state professional examinations, remarking that in all other civilized lands the universities are more open to women than in Germany.

Coming now to the present attitude of the universities to the higher education of women, we find that a great change has taken place during the last few years. While it is still the fact that no German woman can matriculate in any university in Germany, yet the problem of the stand which the universities should take is working out its own solution in the right direction.

The University of Berlin, the largest and in many respects the leading one, has made progress in the matter, although women still work there under great limitations. The cause was injured at the outset in Berlin by the fact that women, often foreigners, who had not the required preparation, rushed into lecture rooms which were open to them from motives of curiosity. This caused such strong feeling among the professors that in one instance a professor, on entering his classroom, saw a lady sitting in the rear, walked up to her, offered her his arm, and led her out of the room.

The first step in the right direction has been to demand either a diploma from some well-known institution, or, as that could not be complied with by German women, the certificate of the teachers' examinations. The possessors of such credentials may attend lectures in any course, where the professor is willing, as *Hospitants*. The conditions under which women may attend the University of Berlin are the following:

1. A written permission must be obtained from the curator of the university on presentation of a satisfactory diploma, a passport, and, by Russian applicants, a written permission from the police authorities to study in Germany.

2. Written permission from the rector.

3. Written permission from the professors or docents whose lectures the applicant wishes to attend.

4. The permission from the rector must be obtained each semester, but from the curator only when a new subject is chosen.

5. The same fee is demanded from women as from men, and women are requested to always carry with them, in attending lectures, the written permission from the rector.

At the public installation of Rector Waldeyer, in October, 1898, both in his address and in that of the resigning rector, Geheimrath Professor Schmoller, the subject of education of women received attention.

Geheimrath Schmoller said that the first condition of further concessions in the matter must be better preparation on the part of the women, and when this deficiency should be provided for the faculty of the university could make the conditions of their attending lectures lighter, perhaps even the same as those for men. Geheimrath Waldeyer made the subject one of three to which he gave equal space, and which he said called for immediate attention in the educational affairs of Germany. The other two subjects were the relation of technical schools to the universities, and university extension. Geheimrath Waldeyer said that he had formerly been opposed to the higher education of women, but had been led to change his mind from seeing that the movement is not an artificial one, but rather the natural result of the present social condition of society, and on the simple ground of right should be forwarded in a legitimate manner. He spoke strongly, however, in favor of the establishment of separate universities for men and women, on account of the natural differences in the working of their minds and the necessity of adapting methods in both instances to their needs.

The number of women in the University of Berlin has increased very rapidly, being in the autumn of 1896 thirty-nine, in the winter of the same year ninety-five. The next year the largest number was nearly two hundred, and in 1897–'98 three hundred and fifty-two were in all inscribed. Nearly half of these were German women. Most of the women in the University of Berlin are in the department of philosophy, but several are pursuing courses in theology and law. These women are of all ages. One from Charlottenburg was sixty-two years old, and, besides this honored lady, there were five others whose white hair testified to an age of from fifty to fifty-five, while the youngest of all was a Bulgarian girl of seventeen.

The first woman to take her degree in the University of Berlin was Dr. Else Neumann, in December, 1898, in physics and mathe-

matics, who succeeded, notwithstanding the difficulties to be contended with in the absence of preparatory study and the necessity for private preparation.

It is not, however, only in Berlin that the desire for university study has taken a strong hold on the German women, but it is shown in other places, not simply by the fact that many of them attend the universities of Switzerland, which are everywhere open to them, but by their also obtaining the advantages in their own land which have so long been denied them.

Heidelberg was the first university in Germany to grant the doctor examination to women, and this was done several years before lectures were open to them. The writer called upon Prof. Kuno Fischer one day in the summer of 1890 to ask permission to attend a lecture which he was to give that afternoon on Helmholtz. He said that he was very sorry indeed, but he was obliged to refuse women the privilege of listening to him, as they were not admitted to the university. I asked when they would probably be admitted, and he replied, speaking in French, "*Jamais, mademoiselle, jamais!*" Four years later, however, a friend of mine took her degree there in the department of philosophy, thus proving that the wisest of men sometimes make mistakes.

Women have for years studied as *Hospitants* in the Universities of Leipsic and Göttingen, but since November, 1897, the conditions of their admission in Göttingen have been made more difficult.

In Kiel the professors who are not willing to allow women to attend their lectures put a star opposite their names in the university programme of the lecture courses, and this star is unfortunately seen opposite the names of all the professors of theology and many of those of medicine. Women began to attend the University of Tübingen in the autumn of 1898, Dr. Maria Gräfin von Linden being the first, who was soon followed by many others.

The degree of Doctor of Philosophy *honoris causa* has been conferred on two women by the University of Munich—in December, 1897, on the Princess Theresa, and in October, 1898, on Lady Blennerhassett, an author, for her researches in modern languages. The Dean of the Philosophical Faculty, accompanied by three professors, visited her in her home in Munich to communicate to her the honor which she had received.

The University of Breslau offers better conditions to women than are provided elsewhere, as might naturally be expected, especially in the department of medicine.

Germany was represented in the International Council of Women, held in London in June of this present year, by Frau

Anna Simson, Frau Bieber Boehm, and Frau Marie Stritt, of Dresden.

It was also decided at this congress that the next Quinquennial International Council of Women should be held in Berlin, and it will without doubt be an occasion that will mark an era in the history of the progress of liberty for the women of Germany.

SCENES ON THE PLANETS.

By GARRETT P. SERVISS.

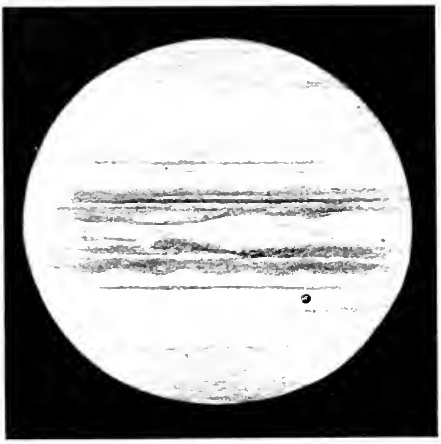
ALTHOUGH amateurs have played a conspicuous part in telescopic discovery among the heavenly bodies, yet every owner of a small telescope should not expect to attach his name to a star. But he certainly can do something perhaps more useful to himself and his friends. He can follow the discoveries that others, with better appliances and opportunities, have made, and can thus impart to those discoveries that sense of reality which only comes from seeing things with one's own eyes. There are hundreds of things continually referred to in books and writings on astronomy which have but a misty and uncertain significance for the mere reader, but which he can easily verify for himself with the aid of a telescope of four or five inches' aperture, and which, when actually confronted by the senses, assume a meaning, a beauty, and an importance that would otherwise entirely have escaped him. Henceforth every allusion to the objects he has seen is eloquent with intelligence and suggestion.

Take, for instance, the planets that have been the subject of so many observations and speculations of late years—Mars, Jupiter, Saturn, Venus. For the ordinary reader much that is said about them makes very little impression upon his mind, and is almost unintelligible. He reads of the "snow patches" on Mars, but unless he has actually seen the whitened poles of that planet he can form no clear image in his mind of what is meant. So the "belts of Jupiter" is a confusing and misleading phrase for almost everybody except the astronomer, and the rings of Saturn are beyond comprehension unless they have actually been seen.

It is true that pictures and photographs partially supply the place of observation, but by no means so successfully as many imagine. The most realistic drawings and the sharpest photographs in astronomy are those of the moon, yet I think nobody would maintain that any picture in existence is capable of imparting a really satisfactory visual impression of the appearance of the

lunar globe. Nobody who has not seen the moon with a telescope—it need not be a large one—can form a correct and definite idea of what the moon is like.

The satisfaction of viewing with one's own eyes some of the things the astronomers write and talk about is very great, and the illumination that comes from such viewing is equally great. Just as in foreign travel the actual seeing of a famous city, a great gallery filled with masterpieces, or a battlefield where decisive issues have been fought out illuminates, for the traveler's mind, the events of history, the criticisms of artists, and the occurrences of contemporary life in foreign lands, so an acquaintance with the sights of the heavens gives a grasp on astronomical problems that can not be acquired in any other way. The person who has been in Rome, though he may be no archæologist, gets a far more vivid conception of a new discovery in the Forum than does the reader who has never seen the city of the Seven Hills; and the amateur who has looked at Jupiter with a telescope, though he may be no astronomer, finds that the announcement of some change among the wonderful belts of that cloudy planet has for him a meaning and an interest in which the ordinary reader can not share.



Jupiter seen with a Five-Inch Telescope. Shadow of a satellite visible.

Jupiter is perhaps the easiest of all the planets for the amateur observer. A three-inch telescope gives beautiful views of the great planet, although a four-inch or a five-inch is of course better. But there is no necessity for going beyond six inches' aperture in any case. For myself, I think I should care for nothing better than my five-inch of fifty-two inches' focal distance. With such a glass more details are visible in the dark belts and along the bright equatorial girdle than can be correctly represented in a sketch before the rotation of the planet has altered their aspect, while the shadows of the satellites thrown upon the broad disk, and the satellites themselves when in transit, can be seen sometimes with exquisite clearness. The contrasting colors of various parts of the disk are also easily studied with a glass of four or five inches' aperture.

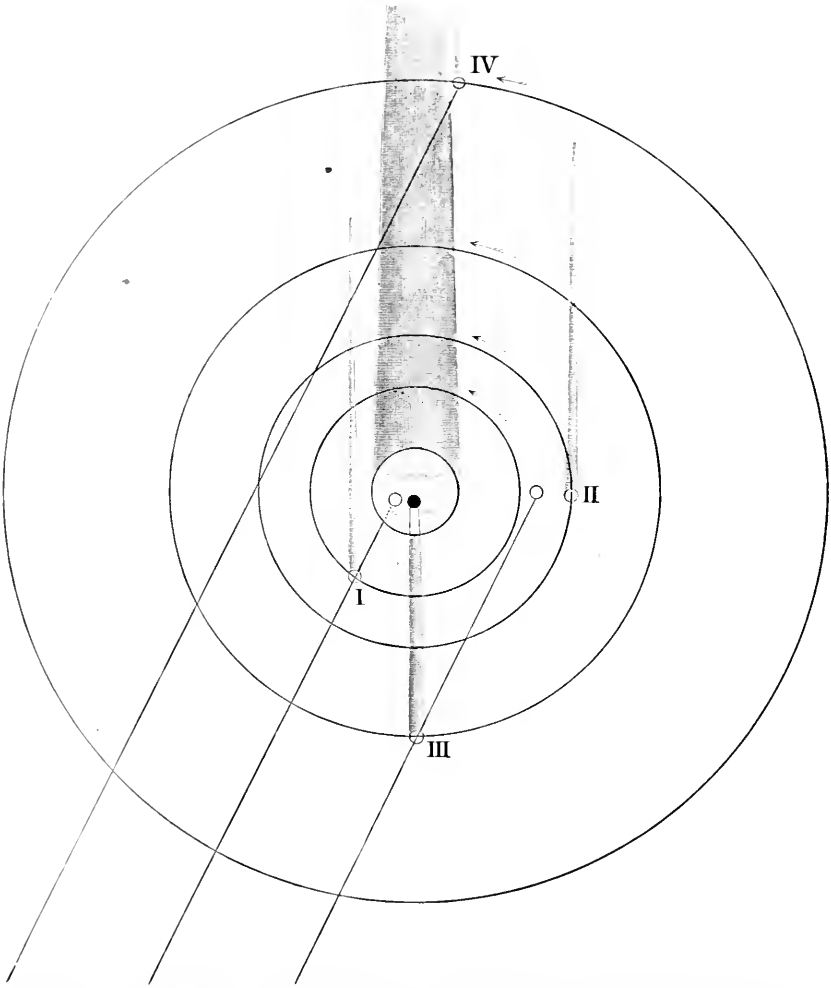
There is a charm about the great planet when he rides high in a clear evening sky, lording it over the fixed stars with his serene, unflickering luminousness, which no possessor of a telescope can resist. You turn the glass upon him and he floats into the field of view, with his *cortége* of satellites, like a yellow-and-red moon, attended by four miniatures of itself. You instantly comprehend Jupiter's mastery over his satellites—their allegiance is evident. No one would for an instant mistake them for stars accidentally seen in the same field of view. Although it requires a very large telescope to magnify their disks to measurable dimensions, yet the smallest glass differentiates them at once from the fixed stars. There is something almost startling in their appearance of companionship with the huge planet—this sudden verification to your eyes of the laws of gravitation and of central forces. It is easy, while looking at Jupiter amid his family, to understand the consternation of the churchmen when Galileo's telescope revealed that miniature of the solar system, and it is gratifying to gaze upon one of the first battle grounds whereon science gained a decisive victory for truth.

The swift changing of place among the satellites, as well as the rapidity of Jupiter's axial rotation, give the attraction of visible movement to the Jovian spectacle. The planet rotates in four or five minutes less than ten hours—in other words, it makes two turns and four tenths of a third turn while the earth is turning once upon its axis. A point on Jupiter's equator moves about twenty-seven thousand miles, or considerably more than the entire circumference of the earth, in a single hour. The effect of this motion is clearly perceptible to the observer with a telescope on account of the diversified markings and colors of the moving disk, and to watch it is one of the greatest pleasures that the telescope affords.

It would be possible, when the planet is favorably situated, to witness an entire rotation of Jupiter in the course of one night, but the beginning and end of the observation would be more or less interfered with by the effects of low altitude, to say nothing of the tedium of so long a vigil. But by looking at the planet for an hour at a time in the course of a few nights every side of it will have been presented to view. Suppose the first observation is made between nine and ten o'clock on any night which may have been selected. Then on the following night between ten and eleven o'clock Jupiter will have made two and a half turns upon his axis, and the side diametrically opposite to that seen on the first night will be visible. On the third night between eleven and twelve o'clock Jupiter will have performed five com-

plete rotations, and the side originally viewed will be visible again.

Owing to the rotundity of the planet, only the central part of the disk is sharply defined, and markings which can be easily seen when centrally located become indistinct or disappear altogether



Eclipses and Transits of Jupiter's Satellites. Satellite I and the shadow of III are seen in transit. IV is about to be eclipsed.

when near the limb. Approach to the edge of the disk also causes a foreshortening which sometimes entirely alters the aspect of a marking. It is advisable, therefore, to confine the attention mainly to the middle of the disk. As time passes, clearly defined markings on or between the cloudy belts will be seen to approach the

western edge of the disk, gradually losing their distinctness and altering their appearance, while from the region of indistinct definition near the eastern edge other markings slowly emerge and advance toward the center, becoming sharper in outline and more clearly defined in color as they swing into view.

Watching these changes, the observer is carried away by the reflection that he actually sees the turning of another distant world upon its axis of rotation, just as he might view the revolving earth from a standpoint on the moon. Belts of reddish clouds, many thousands of miles across, are stretched along on each side of the equator of the great planet he is watching; the equatorial belt itself, brilliantly lemon-hued, or sometimes ruddy, is diversified with white globular and balloon-shaped masses, which almost recall the appearance of summer cloud domes hanging over a terrestrial landscape, while toward the poles shadowy expanses of gradually deepening blue or blue-gray suggest the comparative coolness of those regions which lie always under a low sun.

After a few nights' observation even the veriest amateur finds himself recognizing certain shapes or appearances—a narrow dark belt running slopingly across the equator from one of the main cloud zones to the other, or a rift in one of the colored bands, or a rotund white mass apparently floating above the equator, or a broad scallop in the edge of a belt like that near the site of the celebrated "red spot," whose changes of color and aspect since its first appearance in 1878, together with the light it has thrown on the constitution of Jupiter's disk, have all but created a new Jovian literature, so thoroughly and so frequently have they been discussed.

And, having noticed these recurring features, the observer will begin to note their relations to one another, and will thus be led to observe that some of them gradually drift apart, while others drift nearer; and after a time, without any aid from books or hints from observatories, he will discover for himself that there is a law governing the movements on Jupiter's disk. Upon the whole he will find that the swiftest motions are near the equator, and the slowest near the poles, although, if he is persistent and has a good eye and a good instrument, he will note exceptions to this rule, probably arising, as Professor Hough suggests, from differences of altitude in Jupiter's atmosphere. Finally, he will conclude that the colossal globe before him is, exteriorly at least, a vast ball of clouds and vapors, subject to tremendous vicissitudes, possibly intensely heated, and altogether different in its physical constitution, although made up of similar elements, from the earth. Then, if he chooses, he can sail off into the delightful cloud-land of

astronomical speculation, and make of the striped and spotted sphere of Jove just such a world as may please his fancy—for a world of some kind it certainly is.

For many observers the satellites of Jupiter possess even greater attractions than the gigantic ball itself. As I have already remarked, their movements are very noticeable and lend a wonderful animation to the scene. Although they bear classical names, they are almost universally referred to by their Roman numbers, beginning with the innermost, whose symbol is I, and running outward in regular order II, III, and IV. The minute satellite much nearer to the planet than any of the others, which Mr. Barnard discovered with the Lick telescope in 1892, is called the fifth, although in the order of distance it would be the first. In size and importance, however, it can not rank with its comparatively gigantic brothers. Of course, no amateur's telescope can show the faintest glimpse of it.

Satellite I, situated at a mean distance of 261,000 miles from Jupiter's center—about 22,000 miles farther than the moon is from the earth—is urged by its master's overpowering attraction to a speed of 320 miles per minute, so that it performs a complete revolution in about forty-two hours and a half. The others, of course, move more slowly, but even the most distant performs its revolution in several hours less than sixteen days. The plane of their orbits is presented edgewise toward the earth, from which it follows that they appear to move back and forth nearly in straight lines, some apparently approaching the planet, while others are receding from it. The changes in their relative positions, which can be detected from hour to hour, are very striking night after night, and lead to a great variety of arrangements always pleasing to the eye.

The most interesting phenomena that they present are their transits and those of their round, black shadows across the face of the planet; their eclipses by the planet's shadow, when they disappear and afterward reappear with astonishing suddenness; and their occultations by the globe of Jupiter. Upon the whole, the most interesting thing for the amateur to watch is the passage of the shadows across Jupiter. The distinctness with which they can be seen when the air is steady is likely to surprise, as it is certain to delight, the observer. When it falls upon a light part of the disk the shadow of a satellite is as black and sharply outlined as a drop of ink; on a dark-colored belt it can not so easily be seen.

It is more difficult to see the satellites themselves in transit. There appears to be some difference among them as to visibility in such circumstances. Owing to their luminosity they are best

seen when they have a dark belt for a background, and are least easily visible when they appear against a bright portion of the planet. Every observer should provide himself with a copy of the American Ephemeris for the current year, wherein he will find all the information needed to enable him to identify the various satellites and to predict, by turning Washington mean time into his own local time, the various phenomena of the transits and eclipses.

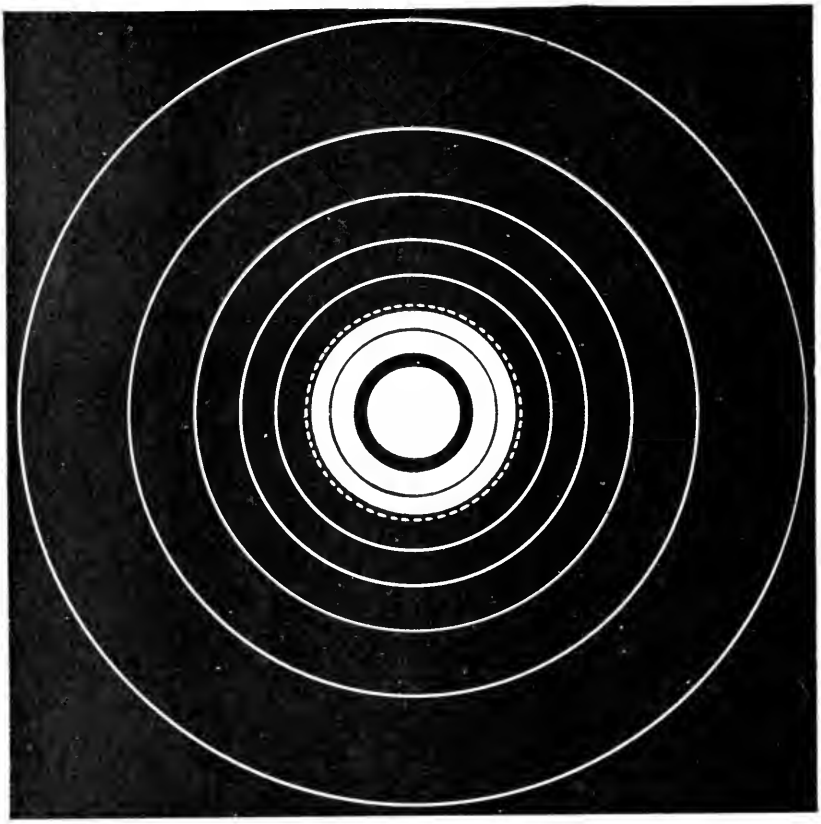
While a faithful study of the phenomena of Jupiter is likely to lead the student to the conclusion that the greatest planet in our system is not a suitable abode for life, yet the problem of its future, always fascinating to the imagination, is open; and whosoever may be disposed to record his observations in a systematic manner may at least hope to render aid in the solution of that problem.

Saturn ranks next to Jupiter in attractiveness for the observer with a telescope. The rings are almost as mystifying to-day as they were in the time of Herschel. There is probably no single telescopic view that can compare in the power to excite wonder with that of Saturn when the ring system is not so widely opened but that both poles of the planet project beyond it. One returns to it again and again with unflagging interest, and the beauty of the spectacle quite matches its singularity. When Saturn is in view the owner of a telescope may become a recruiting officer for astronomy by simply inviting his friends to gaze at the wonderful planet. The silvery color of the ball, delicately chased with half-visible shadings, merging one into another from the bright equatorial band to the bluish polar caps; the grand arch of the rings, sweeping across the planet with a perceptible edging of shadow; their sudden disappearance close to the margin of the ball, where they go behind it and fall straightway into night; the manifest contrast of brightness, if not of color, between the two principal rings; the fine curve of the black line marking the 1,600-mile gap between their edges—these are some of the elements of a picture that can never fade from the memory of any one who has once beheld it in its full glory.

SATURN SEEN WITH A FIVE-INCH TELESCOPE.

Saturn's moons are by no means so interesting to watch as are those of Jupiter. Even the effect of their surprising number (raised to nine by Professor Pickering's discovery last spring of a new one which is almost at the limit of visibility, and was found

only with the aid of photography) is lost, because most of them are too faint to be seen with ordinary telescopes, or, if seen, to make any notable impression upon the eye. The two largest—Titan and Japetus—are easily found, and Titan is conspicuous, but they give none of that sense of companionship and obedience to a central authority which strikes even the careless observer of Jupiter's system. This is owing partly to their more deliberate movements



Polar View of Saturn's System. The orbits of the five nearest satellites are shown. The dotted line outside the rings shows Roche's limit.

and partly to the inclination of the plane of their orbits, which seldom lies edgewise toward the earth.

But the charm of the peerless rings is abiding, and the interest of the spectator is heightened by recalling what science has recently established as to their composition. It is marvelous to think, while looking upon their broad, level surfaces—as smooth, apparently, as polished steel, though thirty thousand miles across—that they are in reality vast circling currents of meteoritic particles or

dust, through which run immense waves, condensation and rarefaction succeeding one another as in the undulations of sound. Yet, with all their inferential tumult, they may actually be as soundless as the depths of interstellar space, for Struve has shown that those spectacular rings possess no appreciable mass, and, viewed from Saturn itself, their (to us) gorgeous seeming bow may appear only as a wreath of shimmering vapor spanning the sky and paled by the rivalry of the brighter stars.

In view of the theory of tidal action disrupting a satellite within a critical distance from the center of its primary, the thoughtful observer of Saturn will find himself wondering what may have been the origin of the rings. The critical distance referred to, and which is known as Roche's limit, lies, according to the most trustworthy estimates, just outside the outermost edge of the rings. It follows that if the matter composing the rings were collected into a single body that body would inevitably be torn to pieces and scattered into rings; and so, too, if instead of one there were several or many bodies of considerable size occupying the place of the rings, all of these bodies would be disrupted and scattered. If one of the present moons of Saturn—for instance, Mimas, the innermost hitherto discovered—should wander within the magic circle of Roche's limit it would suffer a similar fate, and its particles would be disseminated among the rings. One can hardly help wondering whether the rings have originated from the demolition of satellites—Saturn devouring his children, as the ancient myths represent, and encircling himself, amid the fury of destruction, with the dust of his disintegrated victims. At any rate, the amateur student of Saturn will find in the revelations of his telescope the inspirations of poetry as well as those of science, and the bent of his mind will determine which he shall follow.

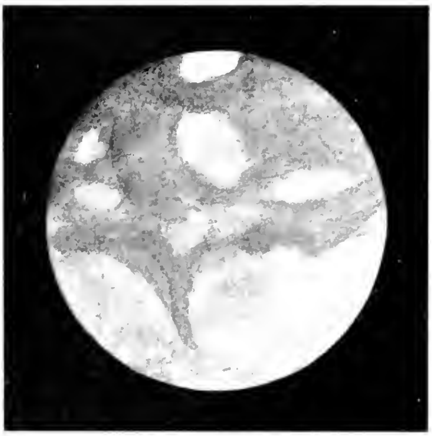
Professor Pickering's discovery of a ninth satellite of Saturn, situated at the great distance of nearly eight million miles from the planet, serves to call attention to the vastness of the "sphere of activity" over which the ringed planet reigns. Surprising as the distance of the new satellite appears when compared with that of our moon, it is yet far from the limit where Saturn's control ceases and that of the sun becomes predominant. That limit, according to Prof. Asaph Hall's calculation, is nearly 30,000,000 miles from Saturn's center, while if our moon were removed to a distance a little exceeding 500,000 miles the earth would be in danger of losing its satellite through the elopement of Artemis with Apollo.

Although, as already remarked, the satellites of Saturn are not especially interesting to the amateur telescopist, yet it may be well

to mention that, in addition to Titan and Japetus, the satellite named Rhea, the fifth in order of distance from the planet, is not a difficult object for a three- or four-inch telescope, and two others considerably fainter than Rhea—Dione (the fourth) and Tethys (the third)—may be seen in favorable circumstances. The others —Mimas (the first), Enceladus (the second), and Hyperion (the seventh—are beyond the reach of all but large telescopes. The ninth satellite, which has received the name of Phœbe, is much fainter than any of the others, its stellar magnitude being reckoned by its discoverer at about 15.5.

Mars, the best advertised of all the planets, is nearly the least satisfactory to look at except during a favorable opposition, like those of 1877 and 1892, when its comparative nearness to the earth renders some of its characteristic features visible in a small telescope. The next favorable opposition will occur in 1907.

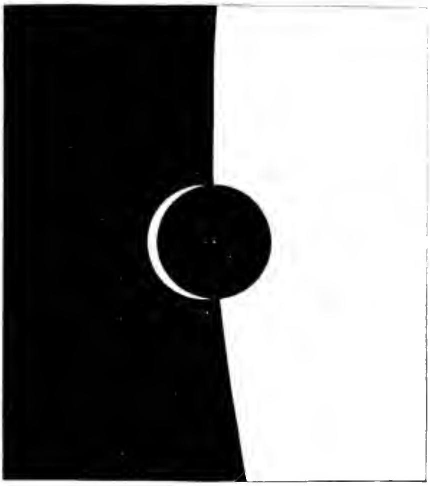
When well seen with an ordinary telescope, say a four- or five-inch glass, Mars shows three peculiarities that may be called fairly conspicuous—viz., its white polar cap, its general reddish, or orange-yellow, hue, and its dark markings, one of the clearest of which is the so-called Syrtis Major, or, as it was once named on account of its shape, "Hourglass Sea." Other dark expanses in the southern hemisphere are not difficult to be seen, although their outlines are more or less misty and indistinct. The gradual diminution of the polar cap, which certainly behaves in this respect as a mass of snow and ice would do, is a most interesting spectacle. As summer advances in the southern hemisphere of Mars, the white circular patch surrounding the pole becomes smaller, night after night, until it sometimes disappears entirely even from the ken of the largest telescopes. At the same time the dark expanses become more distinct, as if the melting of the polar snows had supplied them with a greater depth of water, or the advance of the season had darkened them with a heavier growth of vegetation.



Mars seen with a Five-Inch Telescope.

The phenomena mentioned above are about all that a small telescope will reveal. Occasionally a dark streak, which large in-

struments show is connected with the mysterious system of "canals," can be detected, but the "canals" themselves are far beyond the reach of any telescope except a few of the giants handled by experienced observers. The conviction which seems to have forced its way into the minds even of some conservative astronomers, that on Mars the conditions, to use the expression of Professor Young, "are more nearly earthlike than on any other of the heavenly bodies which we can see with our present telescopes," is sufficient to make the planet a center of undying interest notwithstanding the difficulties with which the amateur is confronted in his endeavors to see the details of its markings.



THE ILLUMINATION OF VENUS'S ATMOSPHERE AT THE BEGINNING OF HER TRANSIT ACROSS THE SUN.

In Venus "the fatal gift of beauty" may be said, as far as our observations are concerned, to be matched by the equally fatal gift of brilliance. Whether it be due to atmospheric reflection alone or to the prevalence of clouds, Venus is so bright that considerable doubt exists as to the actual visibility of any permanent markings on her surface. The detailed representations of the disk of Venus by Mr. Percival Lowell, showing in some respects a resemblance to the stripings of Mars, can not yet be accepted as decisive. More experienced astronomers than Mr. Lowell have been unable to see at all things which he draws with a fearless and unhesitating pencil. That there are some shadowy features of the planet's surface to be seen in favorable circumstances is probable, but the time for drawing a "map of Venus" has not yet come.

The previous work of Schiaparelli lends a certain degree of probability to Mr. Lowell's observations on the rotation of Venus. This rotation, according to the original announcement of Schiaparelli, is probably performed in the same period as the revolution around the sun. In other words, Venus, if Schiaparelli and Lowell are right, always presents the same side to the sun, possessing, in consequence, a day hemisphere and a night hemisphere which never interchange places. This condition is so antagonistic to all our

ideas of what constitutes habitability for a planet that one hesitates to accept it as proved, and almost hopes that it may turn out to have no real existence. Venus, as the twin of the earth in size, is a planet which the imagination, warmed by its sunny aspect, would fain people with intelligent beings a little fairer than ourselves; but how can such ideas be reconciled with the picture of a world one half of which is subjected to the merciless rays of a never-setting sun, while the other half is buried in the fearful gloom and icy chill of unending night?

Any amateur observer who wishes to test his eyesight and his telescope in the search of shades or markings on the disk of Venus by the aid of which the question of its rotation may finally be settled should do his work while the sun is still above the horizon. Schiaparelli adopted that plan years ago, and others have followed him with advantage. The diffused light of day serves to take off the glare which is so serious an obstacle to the successful observation of Venus when seen against a dark sky. Knowing the location of Venus in the sky, which can be ascertained from the Ephemeris, the observer can find it by day. If his telescope is not permanently mounted and provided with "circles" this may not prove an easy thing to do, yet a little perseverance and ingenuity will effect it. One way is to find, with a star chart, some star whose declination is the same, or very nearly the same, as that of Venus, and which crosses the meridian say twelve hours ahead of her. Then set the telescope upon that star, when it is on the meridian at night, and leave it there, and the next day, twelve hours after the star crossed the meridian, look into your telescope and you will see Venus, or, if not, a slight motion of the tube one way or another will bring her into view.

For many amateurs the phases of Venus will alone supply sufficient interest for telescopic observation. The changes in her form, from that of a round full moon when she is near superior conjunction to the gibbous, and finally the half-moon phase as she approaches her eastern elongation, followed by the gradually narrowing and lengthening crescent, until she becomes a mere silver sickle as she swings in between the sun and the earth, form a succession of delightful pictures for the eye.

Not very much can be said for Mercury as a telescopic object. The little planet presents phases like those of Venus, and, according to Schiaparelli and Lowell, it resembles Venus in its rotation, keeping always the same side to the sun. In fact, Schiaparelli's discovery of this peculiarity in the case of Mercury preceded the similar discovery in the case of Venus. There are perceptible markings on Mercury which have reminded some astronomers of

the appearance of the moon, and there are various reasons for thinking that the planet can not be a suitable abode for living beings, at least for beings resembling the inhabitants of the earth. Uranus and Neptune are too far away to present any attraction for amateur observation.

PROFESSOR WARD ON "NATURALISM AND AGNOSTICISM."

By HERBERT SPENCER.

IN a recent advertisement, Professor Ward's work entitled as above was characterized as "one of the most important contributions to philosophy made in our time in England," and this was joined with the prophecy that it "may even do something to restore to philosophy the prominent place it once occupied in English thought." Along with laudatory expressions, I have observed in some notices reprobation of the manner adopted by Professor Ward in his attack upon my views—I might almost say upon me; and one of the reviewers gives examples of the words he uses—"ridiculous," "absurd," "blunder," "nonsense," "amazing fallacy," "our oracle."

When, some time ago, I glanced at one of the volumes, I came upon a passage which at once stamped the book by displaying the attitude of the writer; but, being then otherwise occupied, I decided not to disturb myself by reading more. Now, however, partly by the reviews I have seen, and partly by the comments of a friend, I have been shown that I can not let the book pass without remark. The assumption that a critic states rightly the doctrine he criticises is so generally made, that in the absence of proof to the contrary his criticisms are almost certain to be regarded as valid. And when the critic is a Cambridge Professor and an Honorary LL. D., the assumption will be thought fully warranted.

Let me set out by quoting some passages disclosing the kind of feeling by which Professor Ward's criticisms are influenced, if not prompted. In his preface he says:—

"When at length Naturalism is forced to take account of the facts of life and mind, we find the strain on the mechanical theory is more than it will bear. Mr. Spencer has blandly to confess that 'two volumes' of his *Synthetic Philosophy* are missing, the volumes that should connect inorganic with biological, evolution."

Respecting the first of these sentences, I have only to remark that I have said (as in *First Principles*, § 62) and repeatedly im-

plied, that force or energy in the sense which a "mechanical theory" connotes, can not be that Ultimate Cause whence all things proceed, and that there is as much warrant for calling it spiritual as for calling it material. As was asserted at the close of that work (p. 558), the "implications are no more materialistic than they are spiritualistic; and no more spiritualistic than they are materialistic"; and as was contended in the *Principles of Sociology*. § 659, "the Power manifested throughout the Universe distinguished as material, is the same Power which in ourselves wells up under the form of consciousness."

But it is to the second sentence I here chiefly draw attention. Whether or not there be a sarcasm behind the words "blandly to confess," it is clear that the sentence is meant to imply some dereliction on my part. Now in the programme of the Synthetic Philosophy, the division dealing with inorganic nature was avowedly omitted, "because even without it the scheme is too extensive"; and this undue extensiveness was so conspicuous that I was thought absurd or almost insane. Yet I am now tacitly reproached because I did not make it more extensive still—because an undertaking deemed scarcely possible was not made quite impossible. When blamed for attempting too much, it never entered my thoughts that I might in after years be blamed for not attempting more.

Repeated reference to *First Principles* as "the stereotyped philosophy" are manifestly intended by Professor Ward to reflect on me, either for having left that work during many years unchanged, or for implying that no change is needed. Much as I dislike personal explanations, I am here compelled to make them. If, in 1896, when the ten volumes constituting the Synthetic Philosophy were completed, I had done nothing toward revision of them, the omission would not have been considered by most men a reason for complaint. The facts, however, are, that in 1867 I issued a recast and revised edition of *First Principles;* in 1870 an edition of the *Principles of Psychology*, of which half was revised, and ten years later an enlarged edition of the same work; in 1885 a revised edition of the first volume of the *Principles of Sociology;* and now I have fortunately been able to finish a revised and enlarged edition of the *Principles of Biology*. Any one not willfully blind might have seen that when persisting, under great difficulties, in trying to execute the entire work as originally outlined, it was not practicable at the same time to bring all earlier parts of it up to date. Professor Ward, however, thinks that I should have sacrificed the end to improve the beginning, or else that I should have found energy enough to re-revise an earlier volume while

writing the later ones; and my failure to do both prompts sarcastic allusions.*

In further illustration of the feeling Professor Ward brings to his task, I may quote the following passage, in which he interposes comments on my mode of writing:—

> "By the persistence of Force [capital F], we really mean the persistence of some Power [capital P] which transcends our knowledge and conception. The manifestations, as recurring either in ourselves or outside of us, do not persist; but that which persists is the Unknown Cause [capitals again] of these manifestations."

The matter itself is trivial enough. It is worth noticing only as indicating a state of mind. Supposing even that capitals were in such cases inappropriate—supposing even that small initial letters would have been more appropriate; it is clear that only one having a strong *animus* would have gone out of his way to notice it.

After thus enabling the reader to judge in what temper the criticisms of Professor Ward are made, I may pass on.

As implied at the outset, my intention is not to discuss Professor Ward's own philosophy—the less so because I discussed a like philosophy nearly a generation ago. His position is that "Once materialism is abandoned and dualism found untenable, a spiritualistic monism remains the one stable position. It is only in terms of mind that we can understand the unity, activity, and regularity that nature presents. In so understanding we see that Nature is Spirit." (*Preface.*) This was the position of Dr. Martineau in 1872 (and probably is now). He argued, that to account for this infinitude of physical changes everywhere going on, "Mind must be conceived as there," "under the guise of simple Dynamics." My criticisms on this view, given in an essay entitled "Mr. Martineau on Evolution," can not here be repeated. But I held then, as I hold now, that "the Ultimate Power is no more representable in terms of human consciousness than human consciousness is representable in terms of a plant's functions." Briefly the result is, that in saying "Nature is Spirit" (capital N and capital S!), Professor

* Candor often brings penalties, as witness the announcement "stereotyped edition." When another thousand of a work has been ordered, the printers do not always refer to the author for correction of the title-page, but, as a matter of course, put "second edition," or "third edition," as the case may be. When my attention has been drawn to such matters, however, I have directed that the words "stereotyped edition" shall be put on the title-page if the printing is from plates, and if the work is unaltered: objecting to a usage which betrays readers into the false belief that new matter is forthcoming. I did not perceive that an antagonist might transform the words "stereotyped edition" into an assertion that the work needed no changes. Experience should have warned me that adverse interpretations are inevitable wherever they are possible. To the question—"Why did you stereotype?" the obvious reply is—"From motives of economy."

Ward implies that he knows all about it; while I, on the other hand, am sure that I know nothing about it.

And now, passing to my essential purpose, let me exemplify Professor Ward's controversial method. Specifying an hypothesis of the late Dr. Croll (who, he thinks, had "incomparably more right to an opinion on the question" than I have), he says, that it "at least recognizes a problem with which Mr. Spencer scarcely attempts to deal—I mean the evolution of the chemical elements. It thus suffices to convict Mr. Spencer's work of a certain incompleteness" (i., 190). Apparently the words "scarcely attempts" refer to a passage in the above-named essay, "Mr. Martineau on Evolution," where several reasons are given for thinking that the "so-called elements arise by compounding and recompounding." More than this has been done, however. The evolution of the elements, if not systematically dealt with within the limits of the Synthetic Philosophy, has not been ignored. In an essay on "The Nebular Hypothesis" (*Essays*, i., pp. 156–9), it is argued, that "the general law of evolution, if it does not actually involve the conclusion that the so-called elements are compounds, yet affords *a priori* ground for suspecting that they are such"; and five groups of traits are enumerated which support the belief that they originated by a process of evolution like that everywhere going on. But the point I here chiefly emphasize is that, having reflected upon me for omitting two volumes, Professor Ward again reflects upon me for having omitted something which one of these volumes would have contained. "Sir, you have neglected to build that house which was wanted! Moreover, you have not supplied the stairs!"

From a sin of omission let us pass to a sin of commission. Professor Ward quotes from me the sentence—"The absolutely homogeneous must lose its equilibrium; and the relatively homogeneous must lapse into the relatively less homogeneous."—*First Principles*, p. 429). Then presently he writes:—

"In truth, however, homogeneity is not necessarily instability. Quite otherwise. If the homogeneity be absolute—that of Lord Kelvin's primordial medium, say—the stability will be absolute too. In other words, if 'the indefinite, incoherent homogeneity,' in which, according to Mr. Spencer, some rearrangement *must result*, be a state devoid of all qualitative diversity and without assignable bounds, then, as we saw in discussing mechanical ideals, any 'rearrangement' can result only from external interference; it can not begin from within" (i., 223).

And then he goes on to argue that "Thus, the very first step in Mr. Spencer's evolution seems to necessitate a breach of continuity. This fatal defect, &c." (*ibid.*).

Observe the words "without assignable bounds"—without knowable limits, infinite. So that the law of the instability of the homogeneous is disposed of because it does not apply to an infinite homogeneous medium. But since infinity is inconceivable by us, this alleged case of stable homogeneity is inconceivable too. Hence the proposal is to shelve the law displayed in all things we know, because it is inapplicable to a hypothetical thing we can not know, and can not even conceive! Now let me turn to the essential point. This nominally-exceptional case was fully recognized by me in the chapter he is criticising. In § 155 of *First Principles* (p. 429), it is written:—

> "One stable homogeneity only, is hypothetically possible. If centers of force, absolutely uniform in their powers, were diffused with absolute uniformity through unlimited space, they would remain in equilibrium. This, however, though a verbally intelligible supposition, is one that can not be represented in thought; since unlimited space is inconceivable."

So that this nominal exception which Professor Ward urges against me as a "fatal defect," was set forth by me thirty-seven years ago!

A somewhat more involved case may next be dealt with. Professor Ward writes:—

> "Moreover, on the physical assumption from which Mr. Spencer sets out, viz., that the mass of the universe and the energy of the universe are fixed in quantity—which ought to mean are finite in quantity—there can be no such alternations [of evolution and dissolution] as he supposes" (i., 192).

After some two pages of argument, he goes on:—

> "And so while all transformations of energy lead directly or indirectly to transformation into heat, from that transformation there is no complete return, and, therefore finally no return at all. This then is the conclusion to which Mr. Spencer's premises lead. Two eminent physicists who accept those premises may be cited at this point: 'It is absolutely certain,' they say, 'that life, so far as it is physical, depends essentially upon transformations of energy; it is also absolutely certain that age after age the possibility of such transformations is becoming less and less; and, so far as we yet know, the final state of the present universe must be an aggregation (into one mass) of all the matter it contains, *i. e.* the potential energy gone, and a practically useless state of kinetic energy, *i. e.* uniform temperature throughout that mass. . . . The present visible universe began in time and will in time come to an end'" (p. 194).

Mark now, however, that this opinion of "two eminent physicists," quoted to disprove my position, and tacitly assumed to have validity in so far as it serves that end, is forthwith dismissed as having, for other purposes, no validity. His next paragraph runs:—

> "To this conclusion we are surely led from such premises. But again I ask what warrant is there for the premises? Our experience certainly does not embrace the totality of things, is, in fact, ridiculously far from

it. We have no evidence of definite space or time limits; quite the contrary. Every advance of knowledge only opens up new vistas into a remoter past and discloses further depths of immensity teeming with worlds."

Thus the truth urged against me is that we can not know anything about these ultimate physical principles in their application to the ultra-visible universe. But, unhappily for Professor Ward's criticism, I entered this same caveat long ago. Demurring to that doctrine of the dissipation of energy to which he now demurs, I wrote:—

"Here, indeed, we arrive at a barrier to our reasonings; since we can not know whether this condition is or is not fulfilled. If the ether which fills the interspaces of our Sidereal system has a limit somewhere beyond the outermost stars, then it is inferable that motion is not lost by radiation beyond this limit; and if so, the original degree of diffusion may be resumed. Or supposing the ethereal medium to have no such limit, yet, on the hypothesis of an unlimited space, containing, at certain intervals, Sidereal Systems like our own, it may be that the quantity of molecular motion radiated into the region occupied by our Sidereal System, is equal to that which our Sidereal System radiates; in which case the quantity of motion possessed by it, remaining undiminished, it may continue during unlimited time its alternate concentrations and diffusions. But if, on the other hand, throughout boundless space filled with ether, there exist no other Sidereal Systems subject to like changes, or if such other Sidereal Systems exist at more than a certain average distance from one another; then it seems an unavoidable conclusion that the quantity of motion possessed, must diminish by radiation; and that so, on each successive resumption of the nebulous form, the matter of our Sidereal System will occupy a less space; until it reaches either a state in which its concentrations and diffusions are relatively small, or a state of complete aggregation and rest. Since, however, we have no evidence showing the existence or non-existence of Sidereal Systems throughout remote space; and since, even had we such evidence, a legitimate conclusion could not be drawn from premises of which one element (unlimited space) is inconceivable; we must be forever without answer to this transcendent question." (*First Principles*, § 182, pp. 535–6.)

See, then, how the case stands. After urging against me the argument of "two eminent physicists" as fatal to my conclusions, he thereupon expresses dissent from the premises of that argument; and the reasons he gives for dissenting are like those given by me before he was out of his teens!

It is not always easy to disentangle misrepresentations; especially when they are woven into a fabric. For elucidation of this matter there needs another section. It may fitly begin with an analogy. An astronomer who "saw reason to think" that the swarm of November meteors this year would be greater than usual, would be surprised if the occurrence of a smaller number were

cited in disproof of his astronomical beliefs at large. It would be held that so undecided a phrase as "saw reason to think," not implying a definite deduction, did not implicate his general conceptions nor appreciably discredit them. Professor Ward, however, thinks a tentative opinion is equivalent to a positive assertion. In the course of the foregoing argument (p. 191) he represents me as saying that "there is an alternation of evolution and dissolution in the totality of things." He does not quote the whole clause, which runs thus:—"For *if*, as we saw *reason to think*, there is an alternation of evolution and dissolution in the totality of things, &c." Here, then, are two qualifying expressions which he suppresses; and not only does he here suppress them, but elsewhere he refers to this passage as not speculative, but quite positive. On p. 197 he says:—

"But of a single supreme evolution embracing them all we have no title to speak: not even to assume that it is, much less to say what it is; least of all to *affirm confidently* that it can be embraced in such a meaningless formula as the integration of matter and the dissipation of motion." [The italics are mine.]

So that a hypothetical inference (implied by "if"), drawn from avowedly uncertain data (implied by "reason to think"), he transforms into an unhesitating assertion. He does this in presence of my statement that respecting transformations of the Universe as a whole, no "legitimate conclusions" can be drawn, and that we must be forever "without answer to this transcendent question." Nay, he does it in presence of a still more specific repudiation of certainty. Section 182 begins:—

"Here we come to the question raised at the close of the last chapter—does Evolution as a whole, like Evolution in detail, advance toward complete quiescence? Is that motionless state called death, which ends Evolution in organic bodies, typical of the universal death in which Evolution at large must end? . . .

"To so speculative an inquiry, none but a speculative answer is to be expected. Such answer as may be ventured, must be taken less as a positive answer than as a demurrer to the conclusion that the proximate result must be the ultimate result" (p. 529). Instead of being a positive answer, it is intended to *exclude* a positive answer.

One more instance may be given to illustrate Professor Ward's mode of discrediting views which he dislikes. On p. 198 of his first volume occurs the sentence—

"At any rate such a conception is less conjectural and more adequate than Mr. Spencer's ridiculous comparison of the universe to a spinning top that begins by 'wabbling,' passes into a state of steady motion or *equilibrium mobile*, and finally comes to rest."

The reader who seeks a warrant for this representation will seek in vain. If, in the chapter of *First Principles* on "Equilibration," he

turns to section 171, where the celestial applications of the general law are considered, he will find the Solar System alone instanced as having progressed toward a moving equilibrium; and the moving equilibrium even of this not compared as alleged. Neither in that section nor in any subsequent section of the chapter, is any larger celestial aggregate mentioned as progressing toward a moving equilibrium. Contrariwise, in the succeeding chapter on "Dissolution," it is said that "the irregular distribution of our Sidereal System" is "such as to render even a temporary moving equilibrium impossible" (p. 531). On pp. 533–4 it is contended that even local aggregations of stars, still more the whole Sidereal System, must eventually reach a diffused state without passing through any such stage. And had not conclusions respecting the changes of the Universe been excluded as exceeding the bounds even of speculation (p. 536), it is clear that still more of the Universe would no moving equilibrium have been alleged; but, had anything been alleged, it would have been the reverse. How, then, has it been possible, the reader will ask, for Professor Ward to write the sentence above quoted? If instead of vainly seeking through the sections devoted to "Equilibration" and "Dissolution" in relation to celestial phenomena, he turns back to some introductory pages he will find a clew. I have pointed out that in an aggregate having compounded motions, one of the constituent motions may be dissipated while the rest continue; and that in some such cases there is established a moving equilibrium. In illustration I have taken "the most familiar example"—"that of the spinning top"; and to remind the reader of one of the movements thus dissipated while the rest continue, I have used the word "wabbling"; there being no other descriptive word. What then has Professor Ward done? That mode of establishing an equilibrium which the spinning top exemplifies, he represents as extended by me to celestial phenomena, though no such comparison is made nor any such word used. Nay, he has done so notwithstanding my assertion that a moving equilibrium of our sidereal system is negatived, and regardless of the implied assertion that still more would be negatived a moving equilibrium of the Universe, could we with any rationality speculate about it. Actually in defiance of all this, he says I compare the motion of the Universe to that of a "wabbling" top. Having constructed a grotesque fancy, he labels it "ridiculous" and then debits me with it.

I can not pursue further this examination of Professor Ward's criticisms: other things have to be done. Whether what has been said will lead readers to discount the laudatory expressions I quoted at the outset, it is not for me to say. But I think I have said

enough to warn them that before accepting Professor Ward's versions of my views, it will be prudent to verify them.

Postscript.—I said that I did not propose to discuss Professor Ward's own philosophy, and I contented myself with quoting his summary of it—"Nature is Spirit." It occurs to me, however, that as showing the point of view from which his criticisms are made, it may not be amiss to give readers a rather more specific conception of his philosophy, by reproducing a laudatory quotation he makes. Here it is:—

"If 'rational synthesis' of things is what we seek, it is surely more reasonable to say with Lotze: 'What lies beneath all is not a quantity which is bound eternally to the same limits and compelled through many diverse arrangements, continuously varied, to manifest always the very same total. On the contrary, should *the self-realization of the Idea* [!] require it, there is nothing to hinder the working elements of the world being at one period more numerous and yet more intense; at another period less intense as well as fewer'" (i., 218). [The italics are mine.]

It is worth remarking that on the opposite page some of my views are characterized as "astounding feats of philosophical jugglery"!

DESTRUCTIVE EFFECTS OF VAGRANT ELECTRICITY.

By HUBERT S. WYNKOOP, M. E.

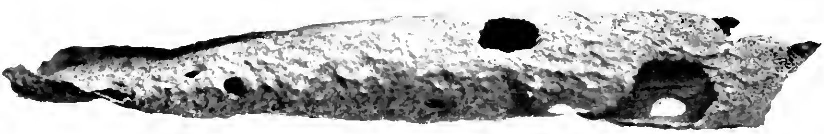
REVERTING to the dictionary for a definition, electrolysis is "the process of decomposing a chemical compound by the passage of an electric current through it." Electroplating is a popular illustration of this definition, having been numbered among the industrial arts for nearly a century.

If in a bath of sulphate-of-copper solution are placed a copper plate and a plumbago-covered wax mold, the passage of an electric current through the solution, *from* the plate *to* the mold, will result in the deposition of copper upon the mold, or negative electrode, and the wasting away of the plate of copper, or positive electrode. Generalizing from this and other experiments, it may be broadly stated that the passage of an electric current through a solution of electrolyzable metallic salt, *from* an oxidizable metal *to* some other conductor, will be attended by the separation of the salt into two parts: first, the metal, appearing at the negative electrode; and, second, an unstable compound of the remaining elements. This unstable compound is supposed to unite with the hydrogen of the water, liberating oxygen, and forming an acid. Both oxygen and acid appear only at the positive electrode, which

is thus made subject to a double decay—a corrosion by oxygen and a solution by acid.

There is nothing new about this. It is not even a novel statement of a fundamental electro-chemical truth. In times past, however, we were wont to consider this matter as pertaining solely to the laboratory or to the electroplating industry; now we are forced to see that the reproduction of this experiment on a grand scale is attended with results as disagreeable as they are widespread.

Hidden beneath our highways lie gas pipes, water pipes, railway tracks, Edison tubes, cement-lined iron subway ducts, and lead-covered cables. These are the electrodes. In contact with these conductors is the soil, containing an electrolyzable salt—chloride, nitrate or sulphate of ammonia, potash, soda, or magnesia, generally. In the presence of moisture this soil becomes an electrolyte, or salt solution. In the absence of electricity no appreciable damage occurs; but the passage of an electric current, no matter how small, from one pipe to another is sure, sooner or later, to leave its traces upon the positive conductor in the form of a decay other than



Copper Drip Pipe after Seventeen Days' Exposure in Salt Water to the Action of Electricity. Half size.

mere oxidation. It is to this decay that has been given the name of *electrolysis;* so that when this heading appears in the daily press or in technical journals one may interpret the term popularly as "the electrolytic corrosion of metals buried in the soil."

To produce electrolytic disintegration of pipes, etc., on a scale grand enough to cause apprehension, a bountiful source of electricity is essential. Unfortunately, this condition is not lacking to-day in any town in which the usual overhead trolley electric railway is in operation. This system of electric propulsion is based upon the use of a "ground return"—that is to say, the electricity passes out from the power house to the bare trolley wire, thence to the pole on the roof of the car, thence through the motors to the wheels, whence it is expected to return to the power house, *via* the rails.

As a matter of fact, however, the released electricity by no means confines itself to the rails and the copper return feeders—legitimate paths provided for it. It avails itself, on the other hand, of what may be termed, for brevity's sake, the illegitimate return—comprising all underground electrical conductors except

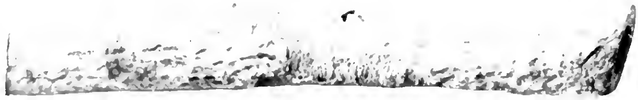
the rails and return feeders, and including subterranean water-courses, sewers, and metallic earth veins.

In the light of our experience of the last eight years, it is easy to identify as electrolysis the effects shown in the accompanying cuts of buried metals that have been actually subjected to a flow of electricity. It is not to be inferred that the destructive action here depicted is universal throughout our towns, but, rather, that the damage occurs in spots, its rate of progress being dependent upon the amount of current and the duration of the flow. Dry, sandy soils tend to keep down the flow of current by interposing a high resistance, so that in such localities electrolytic effects are not as pronounced as in wet, loamy soils. In the same way, the character of the pipe surface—or coating, if there be any—acts as a partial barrier to check the passage of electricity.

Wrought Iron Service Pipe for Water after One Year's Burial beneath a Trolley Track.
The fibrous appearance of the surface is characteristic of wrought iron and steel.

Until recently it was generally supposed that cast iron was not attacked—at least not rapidly enough to cause alarm. In Brooklyn the water mains, of very

hard, dense, even-grained cast iron, containing alloyed rather than combined carbon, have not been appreciably corroded. At Dayton, Ohio, on the other hand, seventy-seven thousand dollars' worth of damage has already resulted. One peculiarity of electrolyzed



LEAD SERVICE PIPE AFTER EIGHT MONTHS' BURIAL IN BUILDERS' SAND. The collapsed appearance of the pipe is due entirely to the removal of the lead by electrolysis, the bore retaining its original shape. The dark spot on the upper surface of the pipe is the point of rupture. One third size.

cast iron is that the original shape is usually retained, the iron being eaten away and leaving a punky formation of pure or nearly pure graphite. In such a case a superficial examination detects nothing wrong, and it requires a mechanical scraping to show that the strength is not there. For this reason good photographs of cast-iron electrolysis are somewhat hard to obtain.

The reason for the comparative immunity of cast iron is not as yet definitely understood. It certainly does not lie particularly in the asphaltic varnish usually applied, for this varnish affords little or no protection when used upon wrought iron or other metals. Nor can it be accounted for by the composition of cast iron itself, inasmuch as a fractured or brightly scraped surface of cast iron shows approximately the same symptoms as other metals when acted upon by a given current for a given time. Whether the iron oxide is the saving feature, or whether the "skin" due to the process of casting acts as an insulator, is not yet settled.

When the trouble first appeared in Boston, in 1891, its cause was promptly identified. The electric-railway construction of those days was so crude, however, that many well-informed electricians fell into the error of assuming that heavier rails, more and larger return feeders, and better bonding (i. e., wire connections from rail to rail, around the joints, designed to decrease the resistance) would prove a panacea for all electrolytic ills. Indeed, this view is still held by a surprisingly large number of men versed in matters electrical.

I am of the opinion that it is impossible, from a financial standpoint, to provide so satisfactory a legitimate return that considerable electricity will not seek a path through pipes, cable covers, etc.; for, in order to confine the electric current to the rails, the resistance of the earth and its contained pipes would have to be infinitely great, and this condition can be realized only by making the resistance of the rail infinitely small as compared with that of

the earth. The cost of arriving at this condition is prohibitive, and the improved track return is, and always must be, a palliative merely, not a cure.

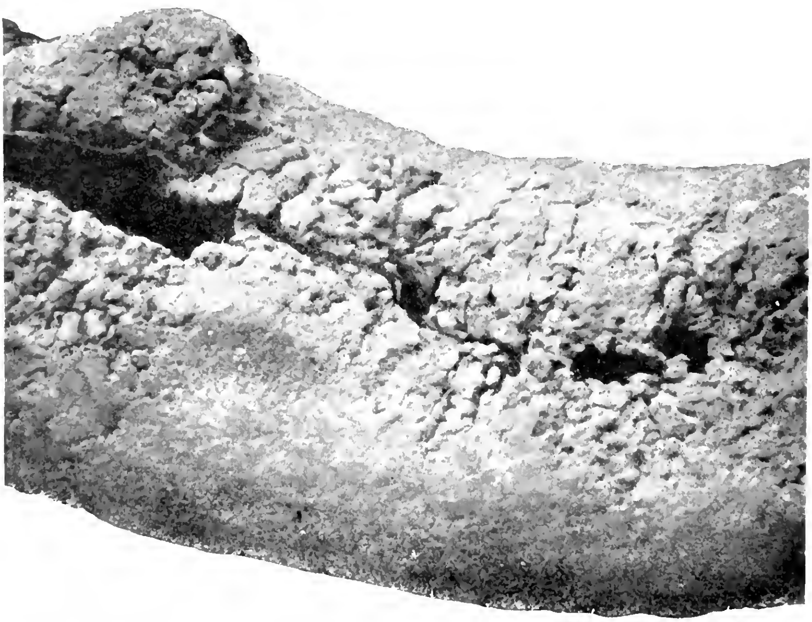
Assuming, then, that under the most favorable character of electric-railway construction some of the current may be expected to stray from the straight and narrow path, it behooves us to consider how it may best be cared for in order that it may not cause electrolysis. Since corrosion of this nature occurs only at those points where electricity *leaves* the metal, one might suppose that the attachment of a conducting wire to the affected part would result in the harmless carrying away of the current. In isolated cases, in small towns, such a plan might accomplish the desired result. It is open to the objection, however, that it in a measure legalizes the conveyance of electricity on conductors other than those designed for the pur-

Lead Service Pipe showing the Effects of Eight Months' Electrolytic Action, and clearly illustrating the Fact that Damage occurs only where the Electricity leaves the Conductor. The interior surface is unattacked.

pose. In larger towns, with more than one power house and with car lines radiating from and circumscribing the business center, the attachment of conducting wires entails a ceaseless disturbance of the electrical equilibrium, curing the evil in spots and developing new danger points. Furthermore, these connections tend to decrease the resistance of the total illegitimate return, thereby

tempting a greater flow of electricity along other paths than the rails and track feeders. It has been generally believed that this increased current would develop electrolysis at the ends of the pipes, due to the jumping of the electricity around the presumably high resistance of the joints; and, indeed, many samples of such corrosion are in existence. I have found, however, that it is possible to calk a bell-and-spigot joint in cast-iron pipe in such a manner that the resistance is practically *nil;* and as for wrought iron or steel, the joint resistance may be made as low as we please by fitting the surfaces so carefully that white-leading is unnecessary.

Arguing from the fact that the negative electrode is not attacked, it has been suggested to employ an auxiliary dynamo and a special system of wiring, in order to maintain the pipes, etc., at all times and at all points, negative to the rails. Could this ideal condition be realized, the rails alone would suffer. We can not



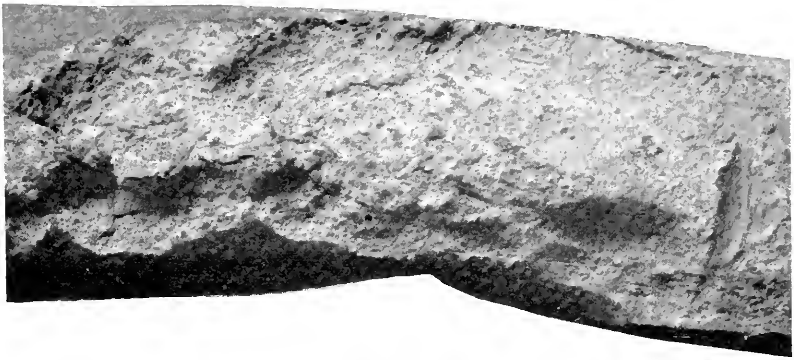
Lead Service Pipe showing the Irregularity of Electrolytic Action, or what is technically known as "Pitting."

hope, however, to thus easily solve the problem in towns where the distribution of buried conductors is at all complex.

It has been suggested, also, to discourage the flow of electricity along pipes and cable covers by inserting insulating sections of wood or terra cotta. This plan has never been tried on a scale large enough to afford a suitable demonstration of its utility. While it might reasonably be tried on new construction, its ap-

plication to old work is almost prohibited by the attendant expense.

Attacking the problem from a directly opposite standpoint, there seems to be a chance of successfully invoking the aid of some purely chemical method of rendering lead and iron innocuous, elec-



Lead Service Pipe illustrating the Local Effects of Eight Months' Electrolysis. The other side of this pipe is smooth and clean.

trolytically speaking. If we can obtain an insulating oxide, lacquer, or varnish that will retain its high-resistance properties during the ordinary lifetime of the buried metal, it will be possible to effectually protect pipes and cable coverings by coating them prior to burial. Or, if we can stumble upon an electrolysis-proof alloy, formed by the addition of a few per cent of some foreign metal to the pipe material during manufacture, the buried conductor will need no protection whatever.

But, supposing that we discover this lacquer or this alloy and by such means guard against damage to all new construction, how are we to care for the metals already buried? We can not dig them all up and paint them, neither can we attempt to replace them by the new alloy. I do not see that the state of the art to-day presents any solution of the difficulty, other than the banishment of the single trolley system. None of the electrical remedies (so called) offers more than partial and temporary relief, and the chemical field is just beginning to be explored.

Permit me to state most emphatically that this is not intended as an argument in favor of the abolishment of single trolley systems. Our civilization owes more to them than could be rehearsed in catalogue form within the limits of one issue of this magazine. We have nothing at present that can be employed as a satisfactory substitute for the ordinary electric railway. The underground trolley is a safe substitute, but the great expense of installation renders it available for very few localities. The overhead trolley,

with two wires and no ground return, is cumbersome, vexatious, and unsightly. The storage battery is more or less experimental in its nature. The electro-magnetic contact systems, with plates set in the pavement at stated intervals, make no pretense of avoiding electrolytic troubles. The compressed-air motor has yet to receive popular approval.

There seems to be a mistaken impression abroad that the railway companies are indifferent to this subject. So far as my experience and information go, this is not the case. They are only too anxious to find a remedy—not, as some electricians have stated, to save their coal-pile, for energy is wasted in forcing the electricity back to the power house, no matter what the path, but because they fear that at some future date the taxpayer, the corporation, and the municipality will band together, present overwhelming bills for damages,

Lead Service Pipe showing the Depth to which the Pipe has been affected.
In this instance the outer covering consists of a salt of lead, having no strength whatever.

and sweep the trolleys off the face of the earth. The instinct of self-preservation, if nothing else, demands that the electric-railway companies should put forth every endeavor to solve the electrolysis problem.

And yet, conservative judgment requires that the railway companies should not take the initiative. It is one of boyhood's maxims not to shoot arrows at a hornet's nest unless one has mud handy to apply to the subsequently afflicted part. Thus it happens that the railway company remains apparently inactive, bearing the burden of public condemnation, while we, whose lethargy is responsible for failing pipes, read electrolysis articles in the daily press and wonder how soon the impending catastrophe is likely to occur.

This condition of affairs is deplorable; for, while we may not care how extensively or how frequently the city authorities or the private corporations are obliged to renew their underground metals, we are at least vitally concerned as to whether the stray electricity is endangering our steel office buildings, our bridges, our water supply, our immunity from conflagrations, and the safety of the hundred and one appliances that go to make up our modern civilization.

Are the Brooklyn Bridge anchor plates going to pieces, or are they not? Are the elevated railroad structures about to fall apart, or are they not? The consulting electrical engineer says "Yes," the railway man says "No." The municipal authorities say nothing. "When doctors disagree——"

I deem it doubly unfortunate that so much valuable brain energy has been inefficiently expended in the discussion of electrolysis. Each writer has viewed it from his own standpoint. Electrical literature has acquired in this way a series of views, interesting and instructive, but also bewildering. There is no composite view, such as might be obtained from the report of a commission composed of a technical representative of each of the interests affected. So far as I am able to learn, such a commission has never existed.

A curious coincidence of superstitions, illustrating anew how all men are kin, is exemplified in the native belief, mentioned in Mrs. R. Langloh Perkins's book of More Australian Legendary Tales, that any child who touches one of the brilliant fungi growing on dead trees—which are called "devil's bread"—will be spirited away by ghosts. An English reviewer of the book remembers having been dragged away from a fungus of this kind for the same reason. In the north of England children used to be told that, if they touched the dangerous growths, a fungus of the same kind would grow from the tip of every finger.

WINTER BIRDS IN A CITY PARK.

By JAMES B. CARRINGTON.

MOST of us are so used to thinking of birds, if we notice them at all, as belonging to spring and summer that we easily fail to see or hear the comparatively few feathered winter visitors. Among these, however, are some of the most attractive and amusing of birds, and to hear their cheery notes and to watch their busy hunt for food on a cold winter day adds a very considerable pleasure to a walk in a city park or the near-by woods. In New York city bird lovers have learned that Central Park is one of the very best places in which to watch birds both summer and winter. There is room enough there and the conditions are varied enough to offer congenial dwelling places for nearly all of the better-known birds. In the spring and fall the beautiful and tiny migrating wood warblers find the park a good feeding ground, and a safe place wherein to linger for a brief time on their journeys north and south.

Mr. Chickadee taking Observations.

With the approach of winter the innumerable fat and saucy robins that have hunted angleworms and strutted about the lawns of the park since early spring disappear, except for an occasional hardy fellow who perhaps prefers the dangers of a northern winter to those of the long journey southward. The wood- and the hermit-thrush; the veery, or Wilson's thrush; the yellow warbler, so abundant and so musical; the perky little redstart, whose song of "Sweet, sweet, sweeter" closely resembles the yellow warbler's; the somber-colored blackbirds; the Baltimore and the orchard oriole; the scarlet tanager; the catbird; Phœbe; Jenny Wren; the tiny chipping sparrow; the vireos; and

many other familiar warm-weather friends have also journeyed southward.

The bare trees and the ground brown with fallen leaves have to some a bleak and dreary look, but this is because a wrong impression has gone abroad concerning them. Nature in winter is not dead, not even sleeping; she is all the time storing up energy to enable her to greet the returning sun in her very best dress. If you will look carefully at the bare limbs and branches of the trees and bushes, you will see the little buds that are slowly but surely swelling up with the pride of young, active, vigorous life, only waiting, with the great patience of Nature, for the proper and suitable time to break away from their winter retirement and take up their part in the new year.

GETTING ACQUAINTED.

Some of the pleasantest days I have ever known in the open have been spent in the winter woods, when the snow was on the ground and everything *seemed* still and unfamiliar. Every little sound is accented on a cold day, and the creaking of a swaying limb or the note of a bird comes to you with almost startling distinctness. Somehow you feel on such days that you are more a part of the things about you than in the full flush of summer. It is like meeting people stripped of all the artificial distinctions of clothes and position.

There is something fine in the way the trees stand up in winter; no one can fail to understand what is meant by the "sturdy oak." They seem to feel pretty much as you do, and show a spirit of vigorous resistance and power to enjoy and cope with the worst that Jack Frost can bring, and the bright sun sends the sap

tingling through their limbs just as it does the blood through yours. One day especially that I remember in Central Park brought me a somewhat novel experience, and gave me the privilege of transferring some old bird acquaintance to the list of my bird friends. It was after a fall of snow, and the air was crisp and sharp, indeed it was nipping, and standing still was a chilly occupation. From long familiarity I knew just about where to go to find certain birds, and I

THE SILENT WINTER WOODS.

was not disappointed in my hunt. My overcoat pocket, it is needless to say, was fully stocked with peanuts and a box of bird seed, and demands were very soon made upon the peanut supply by the fat and friendly gray squirrels that come bravely up to your hand to be fed. They have a most attractive and appealing way of approaching you. The more timid ones stop often to sit up inquiringly, and put one hand on their heart, as if to stop its excited beating.

The first birds I saw were the rugged and noisy English sparrows, written down in most bird books as "pests," but I confess I could not resist giving them a crumb or two, for they appeal to my sympathies much as the plucky little *gamin* newsboys of the streets do, and then, too, I have learned that their loud chatter and rush for food attract more desirable acquaintances. I soon heard the sharp, shrill peep of the white-throated sparrows, and listened to their scratching "with both feet" under the bushes. Now and then one would try his throat with his full song, two sweet whistles followed by very plain calls for "Peabody, peabody, peabody." They are called the peabody bird by many. There is no mistaking this beautiful sparrow. Among a bunch of his noisy English neighbors the rich brown of his feathers is easily seen, and the three white stripes on his head and the white patch on the throat attract your eye at once. In a group of thirty or forty whitethroats that were feeding on my bird seed I noticed also two plump song sparrows. They are brown, too, but smaller than the whitethroats, and their breasts are streaked with dark-brown stripes, with a spot right in the center. This is the sparrow that makes music for us from very early spring until late in the autumn. I have heard them in February, with the snow yet on the ground, perched on the tip of some bush and singing away with a joyfulness that made everything take on a more cheerful look. While I was watching the whitethroats I heard the jolly little song that I especially hoped for, and very soon had a near view of wee Mr. Chickadee himself, with his jet-black head, throat, and chin, and gray cheeks. He, in company with several of his friends, came down to feed at once, and hopped about my feet and a near-by bench to pick up the bits of peanut I had dropped for his benefit. The chickadees are always "chummy" little birds, and seem to have found their human acquaintances in general pretty good sort of people. After a time I put some peanut crumbs in my hand and held it out invitingly. The chickadees would alight on the tree over my head, sing their song, look down inquiringly, and then fly off, apparently interested in searching for some important business they had overlooked on the bark of another tree. Gradually, however, one became more familiar and finally lighted on my hand with entire confidence, selected the largest piece of peanut to be had, and flew away to eat it. He held the bit between both feet on a bench, and leaned forward and pecked away until it disappeared. Occasionally he would hold a small piece in one foot only. One little fellow stopped to sing me his Chick-a-dee-dee-dee, as he perched on my little finger, before selecting his morsel. They followed me about the paths, and wherever I stopped there were sure to be several chicka-

dees peeping about the tree trunks asking me to please give them more peanuts. While this was going on I heard a hoarse "Quank, quank, quank!" that sounded very near, and on looking up saw a white-breasted nuthatch, a blue-gray bird with a very distinct black band on the top of his head that extends back across his shoulders. His short tail and legs make him look very funny when on the ground. On a tree, however, he is a regular circus, walking head up or head down on the limbs and trunk, and now and then doing the giant swing, completely circling some twig, just to show what he can do when he tries. He was attracted by the noise and conduct of the chickadees, his winter companions, and was calling for something for himself. His long, slim bill is not made for cracking things as the sparrows can with their short, strong bills, but he punches holes in them very much as the woodpeckers do. When he came down to the path and picked up a peanut he flew off to a near-by tree and hunted up and down until he found a place in the bark where he could wedge the nut in and then proceeded to hatch or crack it into bits to suit his taste. A brown creeper was walking up his tree a short distance away very much as the nuthatch does, poking his long, curved bill into the bark, though I did not see him for some time, as his brown and gray feathers were so like the color of the tree on which he walked. He circles round the trunk or limb, and you have to keep a sharp lookout to get more than an occasional rapid glance at him. A loud rapping and a noise that sounded a good deal like a giggle attracted my attention to a downy black-and-white woodpecker, with a bright-red spot on the back of his head. He was hammering away with all his might, and the limb on which he hung, back down, fairly rattled as he drove his chisel-like bill into the wood. Another woodpecker, the big and beautifully marked flicker, with his brown back barred with black, his spotted breast with its big black crescent and the red band on the back of his head, stopped for a minute or two on a tree a hundred feet away. His cry of alarm rang out shrilly as he flew away. All of these birds are handsomely marked, though none of them compare, in the mere matter of color, with some of the many beautiful summer species. There was one bird there that day, though, whose brilliant plumage and altogether tropical aspect comes as a great surprise to the unaccustomed visitor to the park in winter. As he lighted on the snow-covered ground among a group of feeding whitethroats the cardinal, with his splendid crest, stood out like a jet of flame, and the black spot at the base of his bill only made the rest of him seem the brighter. Mr. and Mrs. Cardinal spend their winters regularly in Central Park, and I hear

or see them every time I go there. His only note now is a sharp squeak of alarm, but a little later he will perch high up in some tree near the lake and awake the echoes with his loud whistling. High over my head, mere specks of shining white against the blue-gray of the sky, I could see several gulls floating along on their way to the reservoir, where hundreds of them often gather in the open water that is usually found in the center. As I walked toward the entrance of the park, on my way to the car, I heard, on some cedars near the border of the lake, the gurgling music of a party of goldfinches. They had on their winter coats of yellowish brown, but their song and dipping flight made them easily recognizable.

Once you become acquainted with a few birds, every flutter of a wing or cheep or peep becomes an object of interest and a motive for many days in the open. It is very easy also to sentimentalize about Nature and to assume a patronizing air toward her, but the more you know of her and her ways the sooner you get over this. You can not help being impressed with the fact that the life and ways of the animals and birds are, after all, in many ways very like your own. Birds, you will find, are very human indeed, and show a wide diversity in disposition and habit. There is one thing sure to follow an interest of this kind, and that is a greater respect and care for wild life. The cruelty of egg-collecting and the wanton destruction of birds for millinery purposes are becoming less tolerable every year in civilized communities.

OLD RATTLER AND THE KING SNAKE.

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

"I only know thee humble, bold,
Haughty, with miseries untold,
And the old curse that left thee cold,
And drove thee ever to the sun
On blistering rocks. . . .
. Thou whose fame
Searchest the grass with tongue of flame,
Making all creatures seem thy game,
When the whole woods before thee run,
Asked but—when all is said and done—
To lie, untrodden, in the sun!"—BRET HARTE.

OLD RATTLER was a snake, of course, and he lived in the King's River Cañon, high up and down deep in the mountains of California.

He had a hole behind and below a large, flat granite rock, not far from the river, and he called it his home; for in it he slept all night and all winter, but when the sun came back in the spring

and took the frost out of the air and the rocks, then he crawled out to lie until he got warm. The stream was clear and swift in the cañon, the waterfalls sang in the side gulch of Roaring River, the wind rustled in the long needles of the yellow pines, and the birds called to their mates in the branches. But Old Rattler did not care for such things. He was just a snake, you know, and his neighbors did not think him a good snake at that, for he was surly and silent, and his big, three-cornered, "coffin-shaped" head, set on a slim, flat neck, was very ugly to see. But when he opened his mouth he was uglier still, for in his upper jaw he had two long fangs, and each one was filled with deadly poison. His vicious old head was covered with gray and wrinkled scales, and his black, beadlike eyes snapped when he opened his mouth to find out whether his fangs were both in working order.

Old Rattler was pretty stiff when he first came from his hole on the morning of this story. He had lain all night coiled up like a rope among the rocks, and his tail felt very cold. But the glad sun warmed the cockles of his heart, and in an hour or two he became limber, and this made him happy in his snaky fashion. But, being warm, he began to be hungry, for it had been a whole month since he had eaten anything. When the first new moon of August came, his skin loosened everywhere and slipped down over his eyes like a veil, so that he could see nothing about him, and could not hunt for frogs by the river nor for chipmunks among the trees. But with the new moon of September all this was over. The rusty brown old coat was changed for a new suit of gray and black, and the diamond-shaped checkers all over it were clean and shiny as a set of new clothes ought to be.

There was a little striped chipmunk running up and down the sugar-pine tree over his head, pursing his little mouth and throwing himself into pretty attitudes, as though he were the center of an admiring audience, and Old Rattler kept a steady eye on him. But he was in no hurry about it all. He must first get the kinks out of his neck, and the cold cramps from his tail. There was an old curse on his family, so the other beasts had heard, that kept him always cold, and his tail was the coldest part of all. So he shook it a little, just to show that it was growing limber, and the bone clappers on the end rustled with a sharp, angry noise. Fifteen rattles he had in all—fifteen and a button—and to have so many showed that he was no common member of his hated family. Then he shook his tail again, and more sharply. This was to show all the world that he, Old Rattler, was wide awake, and whoever stepped on him would better look out. Then all the big beasts and little beasts who heard the noise fled away just as

fast as ever they could; and to run away was the best thing they could do, for when Old Rattler struck one of them with his fangs all was over with him. So there were many in the cañon, beasts and birds and snakes too, who hated Old Rattler, but only a few dared face him. And one of these was Glittershield,* whom men call the King of Snakes, and in a minute I shall tell you why.

And when Old Rattler was doing all that I have said, the King Snake lay low on a bed of pine needles, behind a bunch of fern, and watched with keen, sharp eye. The angry buzz of Rattler's tail, which scared the chipmunks and the bullfrogs and all the rest of the beast folk, was music for Glittershield. He was a snake too, and snakes understand some things better than any of the rest of us.

Glittershield was slim and wiry in his body, as long as Old Rattler himself, but not so large around. His coat was smooth and glossy, not rough and wrinkly like Old Rattler's, and his upraised head was small and pretty—for a snake. He was the best dressed of all his kind, and he looked his finest as he faced Old Rattler. His head was shiny black, his throat and neck as white as milk, while all down his body to the end of his tail he was painted with rings, first white, then black, then crimson, and every ring was bright as if it had just been freshly polished that very day.

So the King Snake passed the sheltering fern and came right up to Old Rattler. Rattler opened his sleepy eyes, threw himself on guard with a snap and a buzz, and shook his bony clappers savagely. But the King of Snakes was not afraid. Every snake has a weak spot somewhere, and that is the place to strike him. If he hadn't a weak spot no one else could live about him, and then perhaps he would starve to death at last. If he had not some strong points, where no one could harm him, he couldn't live himself.

As the black crest rose, Old Rattler's tail grew cold, his head dropped, his mouth closed, he straightened out his coil, and staggered helplessly toward his hole.

This was the chance for Glittershield. With a dash so swift that all the rings on his body—red, white, and black—melted into one purple flash, he seized Old Rattler by his throat. He carried no weapons, to be sure. He had neither fangs nor venom. He won his victories by force and dash, not by mean advantage. He was quick and strong, and his little hooked teeth held like the claws of a hawk. Old Rattler closed his mouth because he couldn't help it, and the fangs he could not use were folded back against the roof of his jaw.

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* *Lampropeltis zonatus.*

The King Snake leaped forward, wound his body in a "love-knot" around Old Rattler's neck, took a "half-hitch" with his tail about the stomach, while the rest of his body lay in a curve like the letter S between the two knots. Then all he had to do was to stiffen up his muscles, and Old Rattler's backbone was snapped off at the neck.

All that remained to Glittershield was to swallow his enemy. First he rubbed his lips all over the body, from the head to the tail, till it was slippery with slime. Then he opened his mouth very wide, with a huge snaky yawn, and face to face he began on Old Rattler. The ugly head was hard to manage, but, after much straining, he clasped his jaws around it, and the venom trickled down his throat like some fiery sauce. Slowly head and neck and body disappeared, and the tail wriggled despairingly, for the tail of the snake folk can not die till sundown, and when it went at last the fifteen rattles and the button were keeping up an angry buzz. And all night long the King of Snakes, twice as big as he ought to be, lay gorged and motionless upon Old Rattler's rock.

And in the morning the little chipmunk ran out on a limb above him, pursed up his lips, and made all kinds of faces, as much as to say, "I did all this, and the whole world was watching while I did it."

REMARKABLE VOLCANIC ERUPTIONS IN THE PHILIPPINES.

By R. L. PACKARD.

EVERY one knows that the Philippine archipelago, like other regions in its neighborhood, abounds in volcanoes, some of which are still active, while the majority are extinct. Some geologists have tried to distribute the Philippine volcanoes into two parallel belts or lines running in a general northwest and southeast direction, following the trend of the island group, and extending from the southern end of Mindanao to the northern part of Luzon—some sixteen degrees of latitude. Early, possibly prehistoric, volcanic activity in the group has left its imprint upon the native mythology, as was the case in the Mediterranean, and an explanation of some of the mythical stories is to be found in earth movements. The Spaniards have given accounts of many eruptions in the last three hundred years, which were remarkable either from the destruction they caused or the terror they inspired. Some of these accounts were written by the terrified eyewitnesses

themselves, such as the monks in charge of parishes where the greatest damage was done, and are sufficiently vivid, however much they may lack of what would now be called "scientific" accuracy.

Probably the most remarkable volcanic outburst in historical times, on account of the distance apart of the simultaneous eruptions, although its intensity might not be regarded as great when compared with that of Krakatoa, was that of January 4, 1641, when a volcano on the southeastern extremity of Mindanao, another on the northern coast of the island of Sulu to the west, and a third in Luzon far to the north, became active at the same time. A translation of the original Spanish report of this extraordinary phenomenon, which is extremely rare and practically inaccessible to students, is given in Jagor's *Reisen in den Philippinen.* From this it appears that upon two occasions, toward the end of December, 1640, volcanic ashes fell at Zamboanga (on the southwest coast of Mindanao) and covered the fields like a light frost. On January 1, 1641, the auxiliary fleet carrying troops from Manila to the island of Ternate was off Zamboanga, and on the 3d, at about 7 P. M., people in the latter place heard what they supposed was artillery and musketry firing at some miles' distance. Believing that an enemy was attacking the coast, preparations were made to meet him, and the commander of the galleys sent a boat out to see if any of the vessels of the fleet needed assistance, but the boat returned without finding the fleet.

On the next day, January 4, 1641, at about 9 A. M., the noise of the supposed cannonading increased to such an extent that it was feared in Zamboanga that the Spanish fleet had been attacked by the Dutch, with whom the Spaniards were then at war. This noise lasted about half an hour, when it became evident that it was not caused by artillery, but proceeded from the outbreak of a volcano, for, toward noon, thick darkness began to spread over the sky to the south, which soon covered that part of the heavens and gradually spread over the whole sky, so that by 1 P. M. it was as dark as night, and by 2 P. M. the darkness had so increased that one could not distinguish objects a short distance off. Candles were lighted, and a great fear fell upon the people, who fled to the churches to pray and confess. This darkness, during which no light was visible in the whole horizon, lasted until 2 A. M., when the moon became visible, to the great joy of both Spaniards and Indians, who were afraid of being buried beneath the ashes which had been falling since 2 P. M. The fleet, which was then passing the southern end of Mindanao, was thrown into confusion by the tumult of the elements, and was in darkness earlier than Zamboanga—viz., at 10 A. M.—because it was nearer

the volcano. The darkness was so intense that the crews believed the last day had come, and the vessels were endangered by the heavy shower of stones, ashes, and earth which fell upon them and which the men hastened to throw overboard. The ships' lanterns were lighted as at night. The volcano could be seen, at a considerable distance, throwing up columns of flame which, on descending, set the neighboring woods on fire. The darkness covered the greater part of Mindanao, which is a very large island, and the ashes were carried to Cebu, Panay, and other islands, and there was an especially heavy fall on the island of Jolo (Sulu), which is more than forty leagues west by south from the southeast point of Mindanao, where the volcano burst out. On this island, on account of the darkness and the general uproar, the source of the ashes which fell there was not known at the time, but when it became light enough to see it was found that at the same time with the eruption on Mindanao a second volcano had burst out upon a small island which lies off the mouth of the principal river of Sulu. There the earth had opened with a violent commotion, and had vomited out flames mingled with trees and huge stones. So great was the disturbance that the sea bottom was mingled with the interior of the earth, and the volcano threw out quantities of shells and other things that grow upon the bottom of the sea. The mouth of this volcano remained open afterward. It was very broad, and the eruption had burned up everything upon the island. But what excited the greatest amazement was that a third volcano broke out on the same day and hour with the two just mentioned, in the province of Ilocos, in Luzon, and at least six hundred miles north; and this volcano ejected water. The outbreak was preceded by a violent storm and earthquake. The earth swallowed up three mountains, on the sides of one of which were three villages. All three mountains were torn from their foundations and blown into the air, together with a vast amount of water, and the chasm which took their place formed a broad lake, that showed no trace of the mountains which had stood on the spot. The letter from which the foregoing account is taken goes on to say that the noise of this outbreak, which occurred between 9 and 10 A. M., was heard not only in Manila but in all the Philippine Islands and the Moluccas. It even reached the mainland of Asia in the kingdoms of Cochin China, Champa, and Cambodia, as was learned from priests and others who came to Manila from those countries afterward. The noise sounded like heavy artillery and musketry fire at two or three leagues' distance. In Manila it was supposed that the firing was going on in Cavite, while at Cavite it was referred to Manila,

and messengers were sent from one place to the other to make inquiries, and a similar impression prevailed in all the islands, cities, and villages in a circuit of nine hundred leagues, within which the noise was heard. Malacca was taken by the Dutch on the 13th of January, and was already hard pressed on the 4th, and many pious Spaniards believed, after the news had come of the capture of the place, that Heaven had taken this volcanic means of warning them of the great injury which would result to the archipelago from the loss of so important a city.

The missionaries in Cochin China gave January 5th as the date of the outbreak, instead of the 4th, there being one day's difference between the reckoning of the Portuguese, who sailed from west to east, and that of the Spaniards, who sailed from east to west, to their Eastern possessions.

The volcano of Mayon, or Albay, in the province of Camarines, has been in frequent eruption from 1616 down to within thirty years. Some of the eruptions were very destructive to life and property. After an activity in July, 1766, of six days' duration, accompanied by a great flow of lava, on October 23, 1766, during a violent storm, which began at about 7 P. M. from north-northwest and at 3 A. M. suddenly veered to the south and blew down all the houses of one of the villages in the neighborhood, the volcano ejected such a vast quantity of water that several torrents of thirty varas (ninety feet) wide ran down to the sea between the villages Tibog and Albay. Between Bacacay and Malinao the floods were over eighty varas (two hundred and forty feet) wide, and the highways were obliterated. One village was entirely destroyed, nearly all the houses of the region were swept away, and the fields were covered with sand; another village was partly destroyed, its remainder forming an island, or rather a hill, surrounded by deep, broad ravines, through which the stream of sand and water ran. In another place palms and other trees were buried in sand to their tops. Some fifty persons lost their lives. As far as could be judged, the account declares, this [cold?] water came from the interior of the volcano, while we should be inclined to regard it as a cloudburst. The outbreak of February 1, 1814, however, was the most destructive of all. An eyewitness writes that at about 8 A. M. the mountain suddenly threw out a thick column of stones, sand, and ashes, which quickly rose to the highest layers of the air. The sides of the volcano became veiled and disappeared from the view of the spectators, while a stream of fire ran down the mountain and threatened to annihilate them. Every one fled to the highest attainable point for safety, while the roar of the volcano struck terror into all. The darkness increased,

and many of the fleeing ones were struck down by the falling stones. Houses afforded no protection, because the red-hot stones set them on fire, and the most flourishing villages of the Camarines were thus laid in ashes. Toward 10 A. M. the rain of stones ceased, and was replaced by one of sand, and at about 2 P. M. the noise had lessened and the sky began to clear. Twelve thousand persons were killed and many wounded by this eruption. After the mountain had become quiet it presented a frightful appearance, its former picturesque, highly cultivated slopes being covered with barren sand, which enveloped the cocoanut trees to their tops, and some one hundred and twenty feet of its summit had been carried away during the eruption. An enormous opening had been formed on its southern side, near which three other mouths appeared, which continued to emit ashes and smoke. The finest villages of the Camarines were destroyed, and the best part of the province was converted into a sandy waste.

This mountain has been active at short intervals down to the present time. Sometimes its activity has been continuous for a year or more. Its eruptions were frequently accompanied by earthquakes and storms. The next outbreak after that described above was in 1827. In 1834 and 1835 the mountain was active nearly all the time. There was no eruption of ashes, but every night a stream of molten lava could be seen running into the higher ravines. In 1845 there was an eruption of ashes which lasted several days; a violent eruption occurred in 1846, two unimportant ones in 1851, and another violent ash and stone eruption occurred on July 27, 1853, during which thirty-one persons were killed. Others occurred in 1855, 1857, 1858, 1859, 1860, 1865, and 1871. The heights of the Philippine volcanoes vary from ten thousand and nine thousand feet (Albay or Mayon) down to Taal, only seven hundred and eighty feet high. This curious volcano is upon an islet in the middle of Lake Bombon, south of Manila. Lake Bombon was originally probably a vast crater. It is separated from the China Sea by a narrow isthmus. Taal contains secondary craters, crevasses emitting vapors, and lakelets of acid water. It is the principal "show" volcano of the islands, and was in action in 1885, when all the vegetation upon the island was burned up. Lake Bombon was doubtless formerly connected with the sea, the intervening barrier being formed of eruptive *scoriæ*. Its water is still saline, and its marine fauna has adapted itself to its modified environment.

On the small island Camiguin, on the northwest coast of Mindanao, is the extinct volcano Catarman, with a crater lake upon its summit whose level has been subject to great fluctuations. Some-

times the lake dried up, and again it has overflowed and inundated the low lands in the neighborhood, as in 1827 and 1862. Often its water has been set boiling by escaping gases. It would be interesting to know what varying pressure caused the changes in the level of this lake on the top of Mount Catarman.

A further idea of the volcanic activity of this region may be gained from the circumstance that a volcanic island emerged from the sea on the north coast of Luzon in 1856, which grew to seven hundred feet in height by 1860, and is now about eight hundred feet high. Every one has seen photographs of the streets of Manila after an earthquake, which form of subterranean activity is so common that it is taken into account in building.

THE SCAVENGERS OF THE BODY.

By M. A. DASTRE.

THE labors of M. Metchnikoff have made known one of the most curious mechanisms—perhaps the most effective—which Nature employs to protect the organism against the invasion and ravages of microbes. We are only beginning to learn the means which are provided for our defense against the countless swarms of enemies of this class, some of them exceedingly dangerous, among which we have to live and move. In the first rank of these defenses is phagocytosis. The struggle of the organism against its minute assailants is an image of human wars. The cutaneous or mucous integument, continuous over the whole body, constitutes a kind of fortified inclosure which the microbe can not penetrate, except where some breach has been made. On one side of that wall, in the living city, the phagocytes or leucocytes (white cells) form an immense defensive army in a state of continual mobilization, or, as M. Duclaux would say, an innumerable and vigilant police.

These phagocytes or leucocytes are the nomadic elements of our economy. The animal body may be compared to an organized city in which all the living corpuscles, all the cellular elements, are sedentary, each having its place and staying there. Hence the comparison, often made, with the stones of a building, which is not exact, however, because these vital elements grow and increase, enlarging the structure without change of arrangement, while the stones do not. The growth and nutrition of these anatomical elements, it should be added, are carried on exclusively at the expense of liquid matters. Nothing solid can enter them or come out from them.

An exception to these two fundamental rules is found in the single case of the leucocytes or white globules of the blood. They have no fixed or determined place in the organism. Besides being carried passively by the flow of the blood in a perpetual circulation along with the red corpuscles, they possess a motion of their own. They can swim in the current that carries them, fix themselves to the walls, and travel in a sort of creeping way, which has been called the amœboid motion.

They are also exceptions to the second law, according to which living cells can dispose only of liquefied matters. All solid bodies that pass within reach of the leucocytes are seized and incorporated by them, provided they are small or inert enough to be enveloped. The nature of the body is of little import. Whatever it may be, it is swallowed and quickly inclosed within the mass of the leucocyte and submitted to the dissolving action of its juices—or, in a way, eaten. Hence the names "phagocyte," or devouring cell, given to the enveloping white globule, and "phagocytosis" to the process. No other element of the organism, or hardly any other, possesses this singular faculty of seizure and swallowing (*inglobement*).

All the other characteristics of the white globules flow from these two of mobility and phagocytism, the significance of which has been set in a clear light by M. Metchnikoff. These characteristics are the attributes of the most primitive types of animal life. They appertain to cells not yet differentiated, to the unicellular organisms which occupy the first stages of life. They translate the vital energy of elements still independent and isolated, without definite place in the social organization and as yet without special high function, but for that very reason better adapted to the needs of the simplest animality. Their voracity is useful for the preservation of the social organism. By eliminating old, exhausted, diseased cells they rejuvenate the structure and prepare the way for new generations. And when the fecundity of these is exhausted the leucocytes come in to occupy the vacated situations, and conduct the organism thus patched up through a senile degeneracy to natural death.

The leucocytes, white globules, or phagocytes, by virtue of their mobility, are found everywhere—in the blood, in all the organs, and in all parts of the body—but are perhaps most abundant in the blood. The study of them proceeds slowly, and we are still engaged in distinguishing the varieties among them. The most abundant and best known of them—those which answer most closely the description we have given—are those called the polynuclear, neutrophilous leucocytes. They are colored with neutral hues, and have a nucleus like a rolled-up scroll in structure. Other

varieties—the eosinophiles, lymphocytes, etc.—are less mobile and have still less marked phagocytic properties.

The roll-call of the phagocytic army would be a long task. The phagocytes are numerous in the sanguineous fluid, but are still six hundred and fifty times less so than the red corpuscles. They are almost as numerous in the lymph and the conjunctival tissue, where, besides occurring in their normal condition, they sport into a variety which appears to have abandoned its migratory habit, for a time at least, and into a giant variety one hundred times larger than the ordinary leucocytes, which M. Ranvier calls clasmatocytes. They are further found in such tissues as the skin and the mucous membrane, where, notwithstanding the cells are so crowded, they make their way into the intestine, and, by a sort of diapedesis (passage through the pores or interstices) called the phenomenon of Stoehr, toward all the free surfaces, whither exterior soluble substances invite them. As they go they destroy the microbes which, advancing in an inverse direction, would invade the organism and provoke an infection of intestinal origin.

The fact that this immense army of phagocytes is always in motion was first clearly recognized by Cohnheim, in 1867. He saw, in inflamed regions, where the vessels are gorged and distended, the white globules thrusting out a prolongation which seemed to pierce the wall, but in reality simply insinuated itself between its elements, and elongating itself, drew its entire body, as it were, through the narrow channel. This emigration, which is produced without making a break, through the pores and interstices of the vascular wall, has been designated *diapedesis*. It is ordinarily provoked by some foreign body, a pathogenic microbe, for instance, which has introduced itself into the place and spread its irritating secretion or cause of infection there. The phagocytes, attracted from the interior of the vessel, come up and devour the invader. But if they are incapable of dissolving it they bear it away to work their own ruin; they degenerate in their turn, become transformed into globules of pus, and the inflammation results in purulence. The study of the mechanism by means of which the leucocytes traverse the tissues is very interesting.

These remarkable wandering elements are found in all classes of animals, and in all present the same essential characteristics. They are more like free existences than the other cells living in society which compose the bodies of animals, and their history is substantially like that of the naked one-celled organisms. Their various functions and properties are of the highest interest in all departments of physiology. It has been demonstrated, in particular, that the white globules of the blood give rise to the most ener-

getic and most special agencies of living chemistry, to the ferments which determine the coagulation of the blood when drawn from the vessels (coagulating ferment, or thrombosis) and the consumption of sugar (glycolytic ferment), and to numerous diastases. The presence of nuclein in their bodies involves consequences which we are only beginning to perceive.

Behaving like independent beings, the leucocytes or phagocytes perform similar functions with those of the highest animals, feeding, respiring, and reproducing themselves; they move and feel—that is, are impressed by internal excitants. These operations, however, assume with them a character of extreme simplicity. They seem to be the direct result of the physical and chemical properties of the protoplasm that composes them, so that the mysterious side of those vital functions nearly vanishes when we scan them in these their very beginnings. Their respiration is the effect of a sort of affinity between their substance and the vital gas—a chimiotactism directing them toward oxygen. This may be illustrated by forming a microscopic preparation of fresh lymph, imprisoning a few bubbles of air, and sealing it hermetically with paraffin. After two or three hours we can see the leucocytes grouped around the bubbles. When the provision of air is exhausted, several hours afterward, the leucocytes will cease to move and become inert. On inserting a needle, the contact of the air revives them.

The faculty possessed by the leucocytes of seizing solid corpuscles coming in contact with them, inglobing them, and absorbing them, or, as M. Metchnikoff calls it, intracellular digestion or phagocytosis, is easily observed. If we mix fine granulations of carmine or cinnabar, mingled with slightly salted water, with a drop of lymph, we can see the coloring matter penetrating the leucocytary protoplasmic mass, which is soon stuffed with it. The anatomo-pathologists had already observed, in tattooed subjects, white globules charged with grains of charcoal or vermilion. It is legitimate to conclude that some parts of the coloring matter that had been introduced under the epidermis had been taken up by the white globules. This proceeding has been observed in the very act by M. Metchnikoff.

A classic experiment illustrating this operation is now common in our laboratories, and the fact of phagocytosis has come to be regarded as incontestable.

The generality of the phenomenon results from the leucocyte preserving its phagocytic faculty in all its peregrinations, and these peregrinations are unlimited. The tendency of the nomadic elements to push on and insinuate themselves into the finest interstices and the narrowest passages is a rudiment of a tactile sense,

to this extent simply a physical phenomenon, which MM. Mascart and Bordet have clearly distinguished. As soon as a leucocyte touches a resisting body it reacts to the contact by applying the largest possible surface to it. It spreads out, becomes thin, stretches itself along, and ceases deforming itself only after it has obtained the maximum of contact. By such mechanism it penetrates objects that offer it any breach and overcomes them. When the foreign body has been disaggregated into fragments, into small enough grains, phagocytosis intervenes and disposes of the remains. In this way the organism sometimes rids itself of splinters of bone that remain in the tissues after a fracture. So, too, the leucocytes, when occasion arises, repair the blunders of surgeons by extracting and absorbing forgotten objects left in wounds, while at other times they act as auxiliaries by destroying things that have been voluntarily abandoned in them, like threads of catgut in buried sutures and drains of decalcified bone.

There are two conditions, under normal circumstances, in which phagocytosis plays a marked part. The first is the case where vital action brings on the destruction of the organs or the tissues, or, to use exact language, their disintegration in a solid form. The wastes of organic activity are usually in liquid form, and, turned into the blood, they are eliminated in that state through the natural emunctories. Sometimes, however, disintegration results in solid wastes, and the phagocytes do the work of carrying them away. This is the case with the red globules of the blood, which, after a longer or shorter career, are deposited in the spleen and break up into *débris*, some of the parts of which are insoluble in the interstitial liquids. The leucocytes collect around these residues so thickly as sometimes to fuse themselves into a solid mass, a sort of plasmodium or giant cell which digests the *débris*. At other times, and more rarely the isolated leucocytes are not able to absorb the incorporated matters. They then conduct them to the surface of the intestine and discharge them there. A like phenomenon occurs in the liver. The coloring matter of the blood frequently gives rise to insoluble ferruginous deposits which the leucocytes have to convey to the digestive tube. This occurs when a wound provokes an effusion of blood and a mortification of the red globules or of the neighboring anatomical elements. All of the waste that can not take the liquid form and pass in that condition into the circulatory passages is incorporated within the phagocytes. The mechanism of resorption of bone does not seem different.

The phagocytes perform a similar function in another process which very frequently takes place in various animals that pass through metamorphoses, as in insects whose organs are transformed

in changing from one stage of their existence to another, and in tadpoles which lose their tails in becoming frogs; the old parts that disappear are devoured by phagocytes.

Especially in the case of infectious diseases has the protective part performed by the leucocytary phagocytes been brought into full view by M. Metchnikoff. He has shown that the white globules rush to meet the bacterides of inflammation that are introduced through any wound, absorb them, and render them powerless to do harm. In the lymphatic organs—the spleen, the lymphatic ganglions, and the marrow—the white globules are normally accumulated, and there is where the struggle is most active between the bacterides of inflammation which are swarming in the blood and the defensive agents of the organism. The same takes place with the spirilla of recurrent typhus and the microbe of erysipelas.

The leucocytes are capable of adapting themselves to conditions different from those in which they usually live, provided the change is not too abrupt. It may sometimes occur that the poison secreted by a microbe will paralyze and kill the leucocyte, unless care has been taken, by inoculations of virus, at first attenuated and afterward gradually increasing in virulence, to create an immunity in the phagocyte, to make it refractory to the poison and capable of swallowing the toxic bacterium without suffering from it. Explanations have been sought in this property for the virtue of vaccination and the immunity that results from it, but they are evidently only fragmentary, and there are other theories of immunity.

The leucocytes are not always victorious over the microbes, and when these excel in numbers or force it sometimes comes to pass that they are overcome and succumb. Poisoned by the substance they have incorporated, they undergo a fatty degeneration and become globules of pus. Pus is therefore formed of the cadavers of conquered leucocytes. Although that humor ought, for the good of the system, to be rejected, like every other mortified part, it is nevertheless true that the production of it is a beneficent effort, and a salutary reaction of Nature against the morbid agent.

It will be an enduring honor to the name of M. Metchnikoff that he has revealed the importance of the function of phagocytes, and has enriched science with a large number of new truths. A part of this honor will be reflected upon the Pasteur Institute, which has welcomed the eminent biologist for many years, and has intrusted the direction of one of its services to him. The learned Russian, in creating the study of phagocytism, with its causes, mechanism, and consequences, has opened a very extensive field of research to which we have given only a distant and cursory glance.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

Editor's Table.

LIBERAL EDUCATION AND DEMOCRACY.

IN a most thoughtful article, in the Modern Education Series of The Cosmopolitan, President Hadley, of Yale, remarks that the conception of a liberal education changes as forms of government change. "It takes one shape," he proceeds to say, "in a military state, and quite another shape in a state ruled by public opinion. In the former case it will teach the sterner virtues of courage and pride. In the latter case it will teach respect for law, progressiveness, and human sympathy. But in either case a liberal education is an education for citizenship; a development of those distinguishing qualities moral, intellectual, and physical by which the people are to be ruled."

It is a happy definition of "a liberal education" to say that it is "an education for citizenship." From this point of view the *most* liberally educated man will be he who is educated to be a citizen of the world and to feel his relation not only to the present but to the past, and the future as well. Comte had much the same idea when he taught that the moral and social education of the individual was accomplished first by the family, then by the state, and finally by the race. In other words, the egoism of the individual is first tamed by family life, then broadened by political life, and, lastly, humanized in the full sense by conscious participation in the age-long progress of mankind. President Hadley has well chosen the qualities which he says a liberal education under a democracy should aim at developing, but we think he might with much advantage have added another. He will remember that when the poet Horace would describe the character of a high-principled citizen, a man just and firm of purpose, he says that his mind is shaken neither by the lowering countenance of a tyrant nor by the frenzy of the populace commanding vicious courses of policy. In our land and time the *vultus instantis tyranni* is no longer, if it ever was, an object of terror, but the *civium ardor prava jubentium* is a danger, we fear, which has yet to be reckoned with.

In a state, therefore, which is ruled by public opinion one of the qualities which a liberal education should most distinctly aim to impart is firmness to resist popular pressure when exerted in a wrong direction. In like manner, under an aristocracy a truly liberal education would not be one that would tend to perpetuate in the rising generation the faults of the preceding one, or to shut out all criticism of the established *régime;* on the contrary, its tendency should be to temper whatever was extreme or one-sided in the views of the ruling class. The liberality of an education comes in just here, in opening out wider views than would probably be acquired in actual contact with private business or public affairs. When William Pitt, while Prime Minister of England, betook himself to the study of Adam Smith's recently published Wealth of Nations, and began to consider how he could apply the enlightened and philosophical views contained therein to the fiscal policy of the British Empire, he was converting his old-fashioned liberal education into a liberal education of the best kind.

A liberal education, let it be thoroughly understood, is not one which delivers over an individual to the dominant influences of his place and time, whatever they may be, but one which enables him to react, when necessary, against such influences under the guidance of wider views and deeper principles. It is an *illiberal* education, let it embrace what it may, which simply equips a man for exploiting for his own benefit the conditions and tendencies which he finds prevailing in the society around him; and too much of what passes for liberal education has, we fear, had no better result. In a country like ours, liable to be swept by gusts of popular excitement, not to say passion, the aim of all higher education should be to create a class of citizens trained for social influence, and yet able to stand on their guard against sensational politics, to distinguish between true and false patriotism, and to uphold the claims of justice and honor when threatened by popular infatuation and tumult. We read in Thucydides that Cleon, the typical demagogue of ancient Athens, did not hesitate to tell his fellow-citizens that republics were not adapted for holding distant territories in subjection. If Cleon was a demagogue, what are we to think of the highly educated men who in our country echo the popular cry for an imperial policy, and say that millions of people beyond sea who ask only for liberty should be compelled by force of arms to be our subjects? Let our colleges and universities see to it that they understand "a liberal education" in the right sense.

EXTERNAL AND INTERNAL AGGRESSION.

Much surprise has been expressed at the unusual prevalence of violence of all kinds in the United States during the past year. It has seemed quite extraordinary that in a nation devoted, as the American nation is, to vast schemes of philanthropy at home and abroad, such atrocious crimes as the mutilation and burning of negroes and the explosion of dynamite under street cars should be committed. From the sympathetic and self-sacrificing spirit manifested in the enthusiastic response to the appeal to arms to free Cuba and Puerto Rico from Spanish cruelty and despotism, and the repression of the insurrection in the Philippine Islands for the purpose of introducing order and civilization, something quite different was expected. There should have been a deeper interest in the welfare of the negro and a greater effort to protect him in the enjoyment of his rights. There should have been created a tie between capital and labor that no differences about wages or hours of toil could have ruptured with murderous animosities. In a word, there should have been a manifestation of fraternal feeling among all classes and in all sections that would have advanced the United States a long step toward the goal of civilization. So general has been the anticipation of these fruits from the war with Spain that one of the most familiar arguments in favor of it has been the subjective regeneration that would follow the attempt at objective regeneration. That is to say, the American people were to find a cure for their own moral disorders in their cure of the moral disorders of their neighbors.

To a student of the social philosophy of Herbert Spencer it will be no surprise nor disappointment that this expectation, so worthy of a generous and self-sacrificing people, has not been and is not likely to be realized. No truth set forth in his works is more firmly established than his profound induction that external aggression always be-

gets internal aggression—that assaults upon the rights of others abroad leads to assaults upon the rights of others at home. "As it is incredible," he says, "that men should be courageous in the face of foes and cowardly in the face of friends, so it is incredible that other feelings fostered by perpetual conflicts abroad should not come into play at home. We have just seen," he adds, alluding to the proofs of this truth that he has given, "that with the pursuit of vengeance outside the society there goes the pursuit of vengeance inside the society, and whatever other habits of thought and action constant war necessitates must show their effects on social life at large." The facts in support of Mr. Spencer's generalization are to be found in the history of every militant people. He mentions himself the Fijian's sacrifice of their own people at their cannibal festivals, and the prevalence of assassination among the Turks from the earliest times down to the present. He mentions also the hideous acts of cruelty that are to be found in the records of Greek and Roman civilization. To these examples may be added the atrocities committed by Italians upon Italians during the last days of the mediæval republics, and those committed by Frenchmen upon Frenchmen during the French Revolution. "The victories of the Plantagenets in France," said Goldwin Smith, pointing out not long ago the futility of war as a cure for national factiousness, "were followed by insurrections and civil wars at home, largely owing to the spirit of violence that the raids in France excited. The victories of Chatham were followed by disgraceful scenes of cabal and faction, as well as corruption, terminating in the prostration of patriotism and the domination of George III and North."

It is impossible to hope that the United States can be an exception to the social law thus established. However pure the motive that may lie at the bottom of a war of aggression, it can not annul the law. The shedding of blood and the seizure of territory produce a callousness of feeling and a perverted view of the rights of others that are certain to turn the hands striking a foreign foe to the work of domestic strife. Already we have seen with what bitterness such men as Prof. Charles Eliot Norton and Mr. Edward Atkinson have been assailed. We have seen, too, how attempts have been made to discredit the principles of the Declaration of Independence, and to show that the Constitution must not be permitted to stand in the way of what has been politely called the fulfillment of the destiny of the United States. We have seen, finally, how proposals for the disfranchisement of American citizens have been listened to in all parts of the country with a toleration that must cause the old abolitionists to turn in their graves. But the spirit thus manifested has not, we may be sure, failed to contribute to the perpetration of the outrages that have shocked every right-minded observer of current events. It is not a difference of kind but only one of degree that separates the slaughter of Spaniards in Cuba and Tagals in Luzon from the slaughter of negroes in the South and the explosion of dynamite under street cars in the North. The inhuman instincts that impel to the one impel to the other.

Fragments of Science.

Zola's Anthropological Traits.—Mr. Arthur MacDonald has published, originally in the Open Court, a minute anthropological study of the personality of Émile Zola. Passing all the physical points noted, we select a few only of the most peculiar mental traits mentioned by the author. Fear is spoken of as Zola's principal emotion, connected in him with the instinct of self-preservation. He is not much afraid of the bicycle, but shrinks from a ride through a forest at night. He has no fear of being buried alive, yet sometimes when in a tunnel on a railroad train he has been beset with the idea of the two ends of the tunnel falling in and burying him. Some morbid ideas have developed in him, but they do not cause him pain when not satisfied. He lets them run into their "manias," and is then contented. The idea of doubt is one. He is always in fear of not being able to do his daily task, or of being incapable of completing a book. He never rereads his novels, for fear of making bad discoveries. He has an arithmetical mania, and when in the street he counts the gas jets, the number of doors, and especially the number of hacks. In his home he counts the steps of the staircases, the different things on his bureau. He must touch the same pieces of furniture a certain number of times before he goes to sleep. Some numbers have a bad influence for him, and there are good numbers. In the night he opens his eyes seven times, to prove that he is not going to die. He is regarded by the author as a neuropath, or a man whose nervous system is painful but does not seem to affect the soundness of his mind. "In brief, the qualities of Zola are fineness and exactitude of perception, clearness of conception, power of attention, sureness in judgment, sense of order, power of co-ordination, extraordinary tenacity of effort, and, above all, a great practical utilitarian sense."

The Simplon Tunnel.—The following facts are taken from a brief account of this great engineering feat in the Engineering Magazine: There is at present no direct rail connection between western Switzerland and Italy, and to reach Milan it has been necessary to go around to Lucerne and so on through by the St. Gothard route. The distance by rail from Milan to Calais by the Mont Cenis is 665 miles, and by the St. Gothard 680 miles. The distance by way of the Simplon Tunnel will be only 585 miles. The Jura-Simplon Railway from Geneva around the lake and up the Rhone Valley ascends to Brieg at an altitude of about 2,300 feet, while on the Italian side the railway from Milan stops at Domodossola, at an altitude of 900 feet. Between the two, which are 41 miles apart and over an elevation of 6,590 feet, lies the famous Simplon Pass. Connection is now made by diligence, the trip occupying a whole day. The plan of the new railway includes the prolongation of the present line on the Italian side to Iselle, at an altitude of about 2,100 feet, where the Italian entrance to the tunnel was begun in August, 1898. On the Swiss side the entrance is at Brieg, and the tunnel will connect these two towns, being 12.26 miles long. This is nearly three miles longer than the St. Gothard, but the altitude is only 2,300 feet above the sea, instead of 3,800 feet, as at the St. Gothard. The tunnel is to be straight laterally, but higher in the middle than at either end, the grade being 1 in 143 on the Italian and 1 in 500 on the Swiss side. The principal difference between the Simplon Tunnel and those previously pierced through the Alps is that, instead of one single tunnel, two separate tunnels, fifty-five feet apart, are to be constructed, connected by lateral passageways every 650 feet. At first but one of these is to be completed to the full dimensions, the other being carried through at only about a quarter of the ultimate cross-section, and not enlarged and put into use until the traffic demands it. Both tunnels are now being bored by the use of the Brandt hydraulic rotary drills, water being supplied at a pressure of 70 to 100 atmospheres. The borings are through gneiss, lime-

stone, and slate. Holes two inches and three quarters in diameter and four or five feet deep are bored and the rock dislodged by means of dynamite. A narrow-gauge railway is used to remove the *débris*. It is expected that the tunnel will be completed in five years and a half. At the close of 1898, 300 feet had been penetrated on the south side and 1,300 on the north. The estimated cost of the complete double-track tunnels is 69,000,000 francs. This does not include the construction of the permanent way. The Mont Cenis Tunnel cost 75,000,000 francs, and the St. Gothard 59,750,000 francs. The work is practically controlled by the Jura-Simplon Railway.

Grant Allen.—The death of our contributor, Mr. Grant Allen, was mentioned in the last number of the Popular Science Monthly. Mr. Allen was born in February, 1848, the son of the Rev. J. A. Allen, of Wolfe Island, Canada. He attended schools in the United States, in France, and in Birmingham, England, and entered Merton College, Oxford, whence he took his degree of B. A. in 1870. He afterward spent a few years in Jamaica as principal of a college for the higher education of the negro, which had only a brief career. He returned to England and settled down in London for literary work, writing rather on social and scientific than political subjects, for various journals. While he loved and appreciated scientific truth, he rather regarded his subject from the æsthetic side, and this gave a peculiar charm to his articles. He published books on Physiological Æsthetics and The Color Sense, which did not prove profitable. Finding it hard to gain a livelihood from his scientific work, he turned to fiction, and soon found, as the London Times has it, "that his worst fiction was more profitable than his best science." His love of science, however, "approached enthusiasm," and he contributed frequent popular scientific articles to the magazines, so that "for years past hardly one of those publications has been reckoned complete" without contribution of this character from him. He removed from London to Dorking, and afterward went to southern France and Italy for his health. Then, having so far recovered that he could spend his winters in England, he made himself a home at Hindhead, Surrey. Here he died, October 25th, after several weeks' suffering from a painful internal malady. Among his scientific works, his books on Physiological Æsthetics, The Color Sense, and the Evolution of the Idea of God deserve special mention.

Japanese Paper.—The peculiar qualities of Japanese paper, most of them excellent ones, and the great variety of uses to which it is applied, are known everywhere. It is a wood or bark paper, and derives its properties from the substances of which it is made and the method of its manufacture. Several plants are cultivated for the manufacture, which, in the absence of English names, must be called by their Japanese or scientific ones, of which the principal are "mitsumata" (*Edgeworthia papyrifera*), the "sozo" (*Brossonia papyrifera*), and the "gampiju" (*Wickstroannia canecensis*). Bamboo bark also furnishes a good paper, but is not much used. The *mitsumata* ramifies into three branches, and is cultivated in plantations, being propagated from seeds and by cuttings. It is fit for use in the second year if the soil is good. Its cultivation and exportation have reached an enormous importance, largely because the Imperial Printing Office uses it for bank notes and official documents. The *sozo* is propagated by seeds, and somewhat resembles the mulberry. The *gampiju* is a small shrub which is cut in its third year. To make paper, the bark is steeped in a kettle with buckwheat ashes to extract the resin in it. When it is reduced to a pulp, a sieve-bottomed frame with silk or hempen threads is plunged within, very much as in Western paper-making. This, letting out the water, holds the pulp, which, felting, is to form the future sheet of paper. This is pressed, to squeeze all the water out, and is left to dry. The uses made of paper in Japan are innumerable, particularly in old Japan, which treasures up its past. The papers, though all made in a similar way, are called by different names, according to the uses to which they are applied and their origin. Window lights are made of paper, and partitions between rooms, when it is stretched on frames, which work as sliding doors. The cele-

brated lanterns, called *gifu*, are made of it at Tokio and Osaka. Under the name of *shibuganni* it is applied to the covering of umbrellas which are sold in China and Korea. As *zedogawa shi* bank notes are printed on it. Oiled it is *kappa*, impermeable and suitable for covering packages and for making waterproof garments. Handkerchiefs are made from it, cords by twisting. For light, solid articles it is mixed and compressed very much as our papier-maché. Covered with thick paste and pounded, it forms tapestries. Imitations of Cordova leather are made of it by spreading it and pressing it with hard brushes upon boards in which suitable designs have been cut. It is then covered with oil and varnish. Japan produced nearly five million dollars' worth of paper in 1892. Unfortunately, European methods of manufacture have been introduced, and there is danger of the paper losing its distinctive qualities.

The Deeps of the Ocean.—In his geographical address at the British Association, Sir John Murray showed that the deep oceanic soundings are scattered over the different ocean basins in varying proportions, that they are now most numerous in the North Atlantic and Southwest Pacific, and in these two regions the contour lines of depth may be drawn with greater confidence than in the other divisions of the great ocean basins. On the whole, it may be said that the general tendency of recent soundings is to extend the area with depths greater than one thousand fathoms, and to show that numerous volcanic cones rise from the general level of the floor of the ocean basins up to various levels beneath the sea surface. Considerably more than half of the sea floor lies at a depth exceeding two thousand fathoms, or more than two geographical miles. On the Challenger charts all areas where the depth exceeds three thousand fathoms have been called "deeps," and distinctive names have been conferred upon them. Forty-two such depressions are now known—twenty-four in the Pacific Ocean, three in the Indian Ocean, fifteen in the Atlantic Ocean, and one in the Southern and Antarctic Oceans. The area occupied by these deeps is estimated at 7,152,000 geographical square miles, or about seven per cent of the total water surface of the globe. Within these deeps more than 250 soundings have been recorded, of which twenty-four exceed 2,000 fathoms, including three exceeding 5,000 fathoms. Depths exceeding 4,000 fathoms, or four geographical miles, have been recorded in eight of the deeps. Depths exceeding 5,000 fathoms have been hitherto recorded only within the Aldrich Deep of the South Pacific, to the east of the Kermadecs and Friendly Islands, where the greatest depth is 5,155 fathoms, or 530 feet more than five geographical miles. This is about 2,000 feet more below the level of the sea than the summit of Mount Everest, in the Himalayas, is above it.

Death of Sir William Dawson.—By the death of Sir J. William Dawson, at Montreal, November 19th, America loses one of its most highly distinguished geologists. Sir William was born at Pictou, Nova Scotia, in October, 1820, and was deeply interested in the study of Nature from his early college days, when he made extensive collections of various kinds. When he was twenty-two years old a happy fortune brought him in contact with Sir Charles Lyell, then visiting America, and he was that eminent geologist's traveling companion during his scientific tour of Nova Scotia. He studied chemistry at the University of Edinburgh. Returning to Nova Scotia in 1850, he engaged in teaching, and was associated with the first normal school in the province. He was afterward connected with the new University of New Brunswick, and from 1855 to 1893 was Principal of McGill College and University. Although his duties in the college were very exacting, Professor Dawson's industry in scientific research was never relaxed, and he was the author of contributions of very great value to the geology and paleontology of Canada. Among these were the discoveries of the *Dendrepeton acadianum*—the first reptile found in the American coal formations—and the *Pupa vetusta*—the first-known Paleozoic land shell. His discovery and exposition of the *Eozoon canadense* attracted great attention, and was much discussed, but his views of its importance do not seem to have been justified, for some doubts now ex-

ist among geologists whether it represents any organic structure. He was the first President of the Royal Society of Canada, which was organized in 1882; was one of the sectional presidents of the British Association at its Montreal meeting (1884), and was president of that body at its Birmingham meeting, 1886. Among his published works are the Description of the Devonian and Carboniferous Flora of Eastern North America, constituting two volumes of the Reports of the Geological Survey of Canada; Air-Breathers of the Coal Formation; Acadian Geology; The Story of the Earth and Man; Origin of Animal Life; Fossil Men; the Canadian Ice Age; the Meeting Place of Geology and History; the Geological History of Plants (in the International Scientific Series); Relics of Primeval Life (Lowell Lectures); The Chain of Life in Geological Times; Modern Science in Bible Lands; the Dawn of Life; Modern Ideas of Evolution; a book of travels in Egypt and Syria; and many contributions to scientific periodicals. He received numerous degrees and honors from learned bodies and institutions, among them the Lyell medal of the Geological Society of London, in 1882. A sketch of Principal Dawson, as he was then called, was published, with a portrait, in the Popular Science Monthly for December, 1875 (vol. viii, p. 132).

Glacial Lakes in New York.—A glacial lake is defined by H. P. Fairchild, in his paper on Glacial Waters in the Finger Lake Region of New York (Geological Society of America, Rochester, N. Y.), as a body of static water existing by virtue of a barrier of ice. Such impounded waters may exist where a glacier blocks a stream, or where the general land surface inclines toward the glacier foot. The lakes described in Mr. Fairchild's paper belongs to the second class, and were formed in the southern part of the Ontario basin, where the land slopes northward from a plateau of two thousand feet elevation down to Lake Ontario, two hundred and forty-six feet. The high plateau was deeply gashed by the preglacial stream erosion, and in these trenches along the northern border of the plateau lie the present "Finger Lakes." The topography was peculiarly favorable to the production against the bold ice front of a series of distinct valley lakes, in many respects unequaled elsewhere. Between twenty and thirty of these lakes are described in Professor Fairchild's paper, which occupied sites now partly represented by nineteen streams and lakes, beginning with Tonawanda Creek on the west and extending to Butternut Creek (Jamesburg and Apulia) on the east. The local lakes were not of long duration, and their surface level was unstable, changing with the down-cutting of the outlets and with the greatly increased volume of the summer melting of the ice sheet. Consequently, true beaches are usually wanting. The conspicuous evidences are the deltas of land streams, with their terraces, embankments, bars and spits, and the outlet channels. The records of these extinct waters are the very latest phenomena connected with the ice invasion, and are the connecting link between the glacial condition and the present hydrography. They are of lively interest, perhaps, to only a few persons, but the details are necessary to the more general study of the Pleistocene. No economic or practical result from the knowledge is foreseen, "but as pure science the study of these waterless lakes, waveless shores, and streamless channels has a fascination and romance."

The Environment in Education.—"Two considerations of equal and fundamental importance," says Mr. Wilbur S. Jackman, "are included in teaching—the choice of the subject-matter and its presentation, and the reaction of the pupil as the result of the presentation. No presentation ever reaches consciousness without a reaction, however feeble, from which results an immediate and inevitable corresponding mental construction. Certain instincts called primitive, it may be generally agreed, exist in children, and, by taking intelligent advantage of these, definite educative presentation may be begun at a much earlier age than was once supposed. Under the theory that the child repeats the racial history in its growth, a practice has arisen of meeting the early instincts of childhood with presentations from the adult lives of primitive peoples. Presentations are made to stimulate the idea

of hunting and fishing, of building wigwams and the like." But it is a fundamental error, Mr. Jackman believes, to suppose that while the child may be Indianlike in his instincts he is to be considered or treated as an Indian. Another factor of which evolution makes a great deal—the nature of the environment—must be considered, and it is very powerful. The material for satisfying the cravings of the early instincts should therefore be chosen from the immediate environment, to which the pupil's reaction is at once positive and definite. "It is scarcely possible to overmagnify the benefits of an education that seeks first to make the most out of the immediate things of life. Its results and its ideals are about us everywhere. The ability to use in the most intelligent and skillful way the materials of our environment is the necessary condition for the highest purposes and the most glorified ideals. One must have a profound respect for the education that proposes to give us clean cities and hygienic homes."

An Athabascan Indian Lodge.—The caribou-skin lodge of the northern Athabascan Indians is described by Mr. Frank Russell, in his Explorations in the Far North, as supported by a framework of from twelve to thirty poles. In pitching camp in winter, sticks are thrust through the snow in order to find solid earth for a floor. If the stick enters soft moss the place is avoided, as the camp fire would spread and undermine the lodge. When a suitable site is found, the men clear away the snow with their snowshoes, and perhaps assist the women in cutting and carrying the lodge poles. It is the women's duty to carry bundles of spruce boughs with which to cover the floor of the lodge. The brush is carefully laid, branch by branch, so that the stems are under the tops and point away from the center. This floor is renewed every Saturday afternoon. The fireplace is surrounded by a pole of green wood, three or four inches in diameter, cut so as to be bent in the form of a polygon. Above the doorway a pole eight feet long is lashed to the lodge-poles in a horizontal position, six feet from the ground; this, and a similar pole on the opposite side, support from six to twelve poles, crossing above the fire, making a stage on which to thaw and dry meat. Each hunter's powder-horn and shot-pouch are suspended from a lodge-pole or his back, while his gun stands in its cover against a pole or lies on a stage outside. Near the door flap are several hungry and watchful dogs, which, by constantly running in and out, make an opening for the cold wind to enter. The dogs are tied at night. The side of the fire next to the entrance is allotted to the children and visiting women. On either side sit the wives, for there are usually two families in one lodge. Behind them are *muskimoots* and an inextricable confusion of rags, blankets, bones, meat, etc. If a crooked knife, a tea bag, or anything that is in the heap is needed, everything is tumbled about until it is found. The sled-wrapper is extended behind the lodge-poles and serves as a catch-all for stores of meat, bones to be pounded and boiled to extract the grease, and odds and ends not in constant use. The next space is occupied by the men of the house; that farthest from the door is reserved for the young men and the men guests. At night each adult rolls up in a single three-point blanket or a caribou-skin robe, and sleeps on an undressed caribou skin. A piece of an old blanket generally covers the small children in a bunch.

The Sand Grouse.—Pallas's sand grouse is a native of the Kirghiz steppes of central Asia, and occasionally, driven by some pressure of circumstances of which we can only conjecture the nature, makes visits to England. Its presence in that country has never been recorded till this century—more, perhaps, for lack of observers than of migrating birds—but it has appeared in 1863, 1872, 1873, 1888, 1889, and 1899. The principal migration in recent years was in 1888, when many examples were seen and shot in different parts of the country. In the same year it was seen "far and wide" in western Europe, and as far north as Trondhjem, in western Norway. A writer in the Saturday Review remarks on the resemblance of this sand grouse, as described by Prjevalski in central Asia, to the various sand grouse he has seen in South Africa. At the drinking places they circle round the water. Presently they alight and,

Prjevalski says, "hastily drink and rise again, and, in cases where the flocks are large, the birds in front get up before those at the back have time to alight. They know their drinking places very well, and very often go to them from distances of tens of miles, especially in the mornings, between nine and ten o'clock, but after twelve at noon they seldom visit these spots." In the Kalahari country, at the scant desert waters, the Saturday Review writer says, three kinds of sand grouse "are to be seen flocking in from all parts of the country from eight to ten o'clock A. M. for their day's drink. Circling swiftly round the pool with sharp cries, they suddenly stoop together toward the water. The noisy rustle of their wings as they alight and ascend is most remarkable. We noticed that the birds nearest the water drank quickly and moved off, allowing those in the rear to take their places and slake their thirst, the whole process being accomplished with unfailing order and regularity. . . . The spectacle of these punctual creatures, streaming in from all points of the compass with unfailing regularity between eight and ten o'clock was always most fascinating. After drinking they circled once or twice round the water pool, and then flew off with amazing swiftness for their day of feeding in the dry, sun-scorched desert. The seeds of grass and other desert plants seem to constitute their principal food. The sand grouse has some characteristics of the pigeon and some of the grouse, which suggest a 'singular blending' of the two orders."

Plantations for Rural School Grounds.—A paper on the Laying out and Adornment of Rural School Grounds, by Prof. L. H. Bailey, published as a Bulletin of Cornell University Experiment Station, lays down as a general principle in plantation that it should be in the main for foliage effects. "Select those trees and shrubs which are the commonest, because they are the cheapest, hardiest, and likeliest to grow. There is no district so poor and bare that enough plants can not be secured without money for the school yard. You will find them in the woods, in old yards, along the fences. . . . Scatter in a few trees along the fences and about the buildings. Maples, basswood, elms, ashes, buttonwood, pepperidge, oaks, beeches, birches, hickories, poplars, a few trees of pine or spruce or hemlock —any of these are excellent. If the country is bleak, a rather heavy planting of evergreens about the border, in the place of so much shrubbery, is very good. For shrubs, use the common things to be found in the woods and swales, together with the roots which can be found in every old yard. Willows, osiers, witch-hazel, dogwood, wild roses, thorn apples, haws, elders, sumac, wild honeysuckles—these and others can be found in every school district. From the farmyards can be secured snowballs, spireas, lilacs, forsythias, mock-oranges, roses, snowberries, barberries, flowering currants, honeysuckles, and the like. Vines can be used to excellent purpose on the outbuildings or on the schoolhouse itself. The common wild Virginia creeper is the most serviceable on brick or stone schoolhouses. The Boston ivy or the Japanese ampelopsis may be used, unless the location is very bleak. Honeysuckle, clematis, and bittersweet are also attractive." Flowers may be used for decorations.

Destruction of the Birds.—A circular sent us by the New York Zoölogical Society opens with the declaration which is only a moderate expression of the truth, that "the annihilation of the finest birds and quadrupeds of the United States is a crime against civilization which should call forth the disapproval of every intelligent American." The second annual report of the society (for 1897) contains an article on this subject by Mr. William T. Hornaday, which sets forth some remarkable facts concerning the rate at which the destruction of Nature's fair creatures is proceeding. It is not creditable to American science or American manhood that most of the measures that have been adopted for the protection of animal life in this country have been taken in the interest and at the urgency of sportsmen; or, to prevent killing the poor creatures in an irregular way, in order that they may be more conveniently killed in the regular way. Mr. Hornaday has a fairly satisfactory number of reports in answer to his inquiries concerning the rate at which birds are disappearing from thirty-six States.

From these he has compiled a graphic table for thirty States, taking care to keep within the conservative limit in every particular, which shows that forty-six per cent of the birds of the country have been destroyed within the last fifteen years—the State averages ranging from ten per cent in Nebraska and twenty-seven per cent in Massachusetts to seventy-five per cent in Connecticut, Indian Territory, and Montana, and seventy-seven per cent in Florida. In North Carolina, Oregon, and California the balance of bird life has been maintained; and in Kansas, Wyoming, Washington, and Utah it has increased—Kansas, with its law absolutely forbidding traffic in certain birds, being the "banner State." "The western part of the State of Washington reveals the uncommon paradox of a locality being filled up with bird forms because of the clearing away of the timber." The agencies bringing about the destruction of our animal life are many and various. There are the "sportsmen," of whom Mr. Hornaday registers five kinds, all eager to "kill something," hunting for one hundred and fifty-four species of "game birds," and when these fail, taking the song birds in their place. If the reports are true, the boys of America are the chief destroyers of our passerine birds and other small non-edible birds generally. "The majority of them shoot the birds, a great many devote their energies to gathering eggs, and some do both." Then there are the women wearing birds or feathers in their hats. Egg collecting, which was fostered at one time as encouraging interest in natural history, has increased till it has become an abuse as dangerous and destructive as any of the others, and even genuine scientific collectors are advised to call a halt. Mr. Hornaday concludes that "under present conditions, and excepting in a few localities, the practical annihilation of all our birds, except the smallest species, and within a comparatively short period, may be regarded as absolutely certain to occur."

Annual Flowers. — In a Cornell University Agricultural Experiment bulletin on Annual Flowers the authors, G. N. Lauman and Prof. L. H. Bailey, teach that the main planting of any place should be trees and shrubs. The flowers may then be used as decorations. They may be thrown in freely about the borders of the place, but not in beds in the center of the lawn. They show off better when seen against a background, which may be foliage, a building, a rock, or a fence. Where to plant flowers is really more important than what to plant. "In front of bushes, in the corner of the steps, against the foundation of the residence or outhouse, along a fence or a walk—these are places for flowers. A single petunia plant against a background of foliage is worth a dozen similar plants in the center of the lawn. . . . The open-centered yard may be a picture; the promiscuously planted yard may be a nursery or a forest. A little color scattered here and there puts the finish to the picture." If the person wants a flower garden, the primary question is one not of decoration of the yard, but of growing flowers for flowers' sake. The flower garden, therefore, should be at one side of the residence or at the rear, for it is not allowable to spoil a good lawn even with flowers. A good small garden is much more satisfactory than a poor large garden. Many annual plants make effective screens and covers for unsightly places. Wild cucumber, cobœa, and sweet peas may be used to decorate the tennis screen or the chicken-yard fence. Efficient screens can be made of many strong-growing and large-leaved plants, such as cannas, castor-beans, sunflowers, or tobacco.

A Thirteenth-Century Miracle.—The legend of St. Prokopy relates that on the 25th of June, 1290, the city of Wilikij Ustjug, government of Vologda, southern Russia, was imminently threatened by a violent storm. The populace appealed to the saint, and, by virtue of his prayers, the storm changed its direction, and, passing on one side of the city, spent its fury upon a desert spot about fifteen miles away, where it left, with hail, a mass of fire-marked stones, the fall of which wrought great havoc with the undergrowth. The incident made a deep impression upon the minds of the people, so that the story is still current and alive after the lapse of six hundred years. A testimony to what the people believe is its truth

may be found by visiting the spot, where a surface extending along about four miles is covered with blocks of stone, assumed to be meteorites. A church dedicated to St. Prokopy has been built in the neighboring village of Loboff or Catoval, and near it stands a curious little wooden chapel of great antiquity, the foundation of which was made of the stones that fell. The church is decorated with pictures of St. Prokopy and of incidents of the meteoric storm, and one of the stones that fell has been mounted on a pedestal in the cathedral of Ustjug, where it is an object of devotion. Mr. Melnikoff, Conservator of the Mineralogical Collections of the Mining Institute of St. Petersburg, has examined the place and the stones, and finds that they are not meteoric and heavenly at all, but simply earthly granite and sandstone. Yet M. Stanislas Meunier suggests, in *La Nature*, that the story, so carefully treasured up for six hundred years, may have a foundation. That such stones as lie on the ground at Catoval may have been taken up and transplanted by a tornado of extreme violence he regards as within the possibilities. M. Meunier has himself investigated a phenomenon of the kind in France, where the ground was "mitrailled" with stones measuring one, two, and three cubic centimetres, which had been brought a distance of one hundred and fifty kilometres. Another possible explanation is that the stones were already there, so concealed by the dense growth as not to attract particular attention, but became more plainly obvious when the ground had been cleared by the tornado.

MINOR PARAGRAPHS.

While it recognizes the desirability of agreeing upon some language as a general medium of communication between nations, the London Spectator presents certain forcible reasons for not seeking to institute one universal language. "Mankind," it says, "will never adopt a universal language, nor is it to be desired that it should. The instrument for expressing thought must vary with the character, history, and mental range of those who have thoughts to express, and if all men spoke alike, ninety-nine per cent of them would be speaking stiffly—not using, that is, a natural and self-developed vehicle of expression. Arabic could not have grown up among Englishmen, or English among Arabs. The seclusion of nations, too, from one another by the want of a common tongue is by no means all loss, and we may doubt with reason why the higher races would not be degraded if they understood without effort all that the lower races say to one another. They would be bred, as it were, in the servants' hall, not to their advantage."

In a recent address on The Chemistry of the Infinitely Little, M. Grimaux referred to the fact, with which all who have thought about it have been struck, that pathogenic microbes being diffused all through the atmosphere, everybody must breathe and absorb all sorts of them, including germs of typhoid fever, scarlet fever, diphtheria, etc., and yet we are not all attacked with those diseases. Why? Because each person has a peculiar temperament, and cells adapted, to a greater or less extent, to resist the microbe, to destroy it when it enters the organism, and thus constitutes, as the case may be, a good or a bad cultural medium. Every one, we might say, is immune against some or other of the pathogenic microbes. Like immunity belongs also to certain animal species, and if a microbe pathogenic to man or to some other species is injected into them they will resist it. The blood of refractory animals probably contains principles not yet known which oppose the development of the infectious microbe. From this fact the idea has been suggested of injecting the blood of refractory animals and communicating an artificial immunity to the individual to whom the injection is applied.

M. J. Crépin, of Paris, "an enthusiast concerning the goat," as M. de Parville calls him in *La Nature*, has established a model goat dairy, and is endeavoring to diffuse a taste for goat's milk and its products. As a means to this end, he has sought to procure an improved breed of goats, and has obtained a stock of very satisfactory quality by crossing the best native goats

with the Nubian buck. The latter animal is rather awkward in form and movement, but M. Crépin hopes to breed that out. Otherwise the Nubian is well acclimated, vigorous, and indifferent to cold, hornless, and a most excellent milker. Goat's milk generally is richer in caseine than cow's milk, and owes some of its special qualities to this fact, and to the further circumstance that the flecks of goat-milk cheese are smaller, softer, and more easily broken up—consequently more digestible—than those of cow's milk. Further, goat's milk is more nearly than any other common milk like in composition to human mother's milk; and it has the very great advantage that, the goat being less subject to attacks of tuberculosis and other dangerous disorders, it is comparatively free from the liability to convey infection. A single objection to the general use of goat's milk is the odor which is supposed to be characteristic of it, but M. Crépin affirms that this is not apparent when the goats are properly bred and kept. M. Crépin is experimenting with butter from goat's milk, and represents that he finds it very nice.

The fundamental principle involved in the new form of telemeter, or instrument for estimating the distance of visible objects without actual measurement, invented by Herr Zeiss, of Jena, is that of the stereoscopic effect which appears in natural vision, where the inclination of the eyes in concentrating on the object gives the sense of distance. The base line between the eyes is increased in the Zeiss instrument by means of a system of prisms so as to give a widened base of binocular vision, and of mirrors which give magnifying power. Double images are formed, the distance between which varies in proportion to the distance from the observer, and appliances are provided for measuring how far apart they are. The arrangement is fairly satisfactory for moderate distances—say of 3,000 metres, or about 10,000 feet.

M. Moissan believes that he has found a solution of the problem of the manufacture of ammonia from the atmosphere, and consequently of rendering atmospheric nitrogen available in agriculture, by the artificial production of calcium nitride. While calcium undergoes no change in contact with nitrogen at the ordinary temperature, it is affected by it under the operation of heat, and finally burns in it, absorbing it rapidly and giving rise to a bronze-colored nitride. Thrown into water, this substance decomposes with effervescence, producing ammonia and calcium hydrate.

Prof. A. E. Dolbear, of Tufts College, Massachusetts, patented an invention for telegraphing without wires in 1886, which he claims covers all that Marconi is doing. He has sent messages with it for as long distances as five miles. According to his account he invented the system and made successful experiments with it as far back as 1882. He made an application for a patent, which was rejected by the Patent Office with the statement that it was contrary to science and would not work. "But as it did work, the claim was maintained in the office, and four years later, in 1886, a patent for it was issued." Professor Dolbear does not wish it to be understood that his patent is on the "art of wireless telegraphy," but that it covers everything that has been so far done in the art.

On the occasion of the visit of the French Association to the British Association, Prof. J. J. Thomson gave an exposition of the lines of research by which it has been concluded that the atom is not the smallest existing quantity of matter. Electro-chemical phenomena teach us to associate a definite amount of electricity with each atom of matter; but these recent researches indicate that under certain circumstances a much larger quantity of negative electricity may be conveyed by the atom, or else that the negative electrical charge resides on a small detachable portion of the "atom," which alone is concerned in the experiments. The positive charge seems to be distributed over the whole mass of the atom.

The merits of two methods of clarifying sewage—by dilution and by bacterial action—are discussed by Mr. Rudolph Hering in articles in the Engineering Magazine. Disposal by dilution in large streams of water is regarded as satisfactory in many places—where the water of the stream is not to be used

for drinking or cooking—provided the flow of the stream is always copious enough to dilute and disperse the sewage so widely as to prevent putrefaction and substitute oxidation. For purification by bacterial action no single method is found adapted to all conditions. The method by filtration and aëration is declared practicable only in localities where a sufficient area of porous land is available, upon which the crude sewage can be spread in sufficient quantity, into which it can filter with the proper velocity, and from which it can emerge as a thoroughly purified water. Where these conditions are absent, other methods must be adopted, of which the experiments in artificial filtration by tanks, as practiced at Exeter and Sutton, England, are described. These experiments promise to improve the present method, but perhaps not as greatly as is anticipated by the promoters. The author regards a prior separation of the suspended or dissolved organic matter as essential to permanent success when the amount of land is limited.

By using the tuberculin test the faculty of the Ohio Agricultural Experiment Station have learned that in cattle the tubercle bacillus usually first obtains its foothold in some of the minor glands, that it may exist there for months and years before any other organs are affected, and that it is only in advanced cases that the lungs become diseased. While the growth of the organism is limited to these minor glands the health of the animal usually shows no sign of impairment. During this period there is no evidence that any unwholesome effect is being produced upon the flesh, and so long as the infection is localized in this way in one or two organs the Government inspectors pass the meat as sound. Tuberculosis, therefore, is a very different complaint from such diseases as pleuropneumonia or Texas fever, in which the whole system is saturated from the first instant with the febrile symptoms.

NOTES.

Mr. James Weir tells of a spider which stretched its web in the division between two parts of a sawmill, where the lower fastenings of the structure were frequently broken by the repeated passing of lumber through. Discovering the situation, the insect gave up the use of guy threads, and, finding a nail, wove it into the lower edge of its web, so that it should operate as a sinker to keep the web stretched.

N. G. Johnson, of the Maryland Agricultural Experiment Station, telling the Society for the Promotion of Agricultural Science the story of his fight with the pea louse, represented that the pea raisers in his State had lost this year more than three million dollars by the ravages of this insect. A parasite had been discovered which practically annihilated the pest, but the discovery was not made in time to save the crops in some parts of the State from destruction.

The American Society for the Promotion of Agricultural Science, after hearing the account of the work of the Gypsy Moth Commission of Massachusetts, which has spent more than a million and a half of dollars in trying to exterminate the mischievous insect, approved the action of the Massachusetts Legislature in maintaining the commission, and requested that the work be kept up for a short time longer. This was because it was represented that the moth was now confined to a limited area, and could be easily exterminated by the expenditure of a small amount more of money.

The history of science has sustained a great loss by the burning of most of the relics which had been collected for the Volta Centenary Exhibition at Como, Italy. Only a few things were saved, comprising a sword presented by Napoleon Bonaparte to Volta, a cast of the skull of the great electrician, his watch, and a few personal relics. On the other hand, his books and manuscripts, his collection of batteries, the only authentic portrait of him, and his will, were destroyed. Nevertheless, the celebration was not stopped. The fire was attributed to the fusing of some electric wires.

An example of patient industry is the sorting of hogs' bristles as it is carried on at Tientsin, China. Each one of the hairs of the six hundred thousand kilogrammes exported from that place in 1897 had to be picked out, measured, and placed in the bundle of hairs of corresponding length; and the different lengths by which the hairs are sorted are very numerous.

It is stated by M. Léon Vaillant that the late M. A. d'Abbadie had and used an effective remedy against the

bites of insects and the infections they bring by fumigating the entire body with sulphur. For this purpose he covered the unclothed body with a suitable envelope, under which the sulphur was burned. The remedy was communicated to M. d'Abbadie by a hippopotamus hunter who had, by using it, escaped all the diseases incident to the swamps to which he had to resort.

The Gregorian Calendar is to be adopted by the Russian Government on January 1, 1901, or at the beginning of the new century.

The following figures, from the Engineering and Mining Journal, are of interest as showing the enormous quantity of iron and steel which was manufactured in 1898, and the leading position which the United States has already assumed in the industry:

Iron and Steel Production, in Metric Tons.*

Countries.	Pig Iron.		Steel.	
	1897.	1898.	1897.	1898.
United States.	9,807,123	11,962,317	7,289,200	9,045,815
United Kingdom	8,930,086	8,769,249	4,559,736	4,639,042
Germany	6,889,087	7,402,717	5,091,294	5,734,307
Total..	25,626,296	28,134,383	16,940,330	19,418,664
Austria-Hungary.	1,205,000	1,250,000	553,000	605,500
Belgium..	1,024,666	982,718	616,604	653,130
Canada..	41,500	46,880	....	....
France...	2,472,143	2,534,427	1,281,595	1,441,633
Italy.....	12,500	12,850	57,250	58,750
Russia...	1,857,000	2,228,850	831,000	1,095,000
Spain....	282,171	261,799	121,800	112,605
Sweden..	533,800	570,550	268,300	289,750
All other.	450,000	545,000	310,000	355,000
Grand total.	33,505,076	36,507,487	20,979,179	24,030,032

* A metric ton is about 2,200 pounds.

Although fewer casual members or members for the year than usual were present at the recent meeting of the British Association at Dover, the attendance of distinguished men of science and of active scientific workers, according to the London Times, seemed to be greater. And so far as the proper work of the association is concerned, the meeting should take a high rank. Excellent and serious work was done in all the sections.

A paper has been published by Pliny T. Sexton, of Palmyra, N. Y., setting forth reasons for favoring the unification of the whole educational system of the State of New York under the jurisdiction of a single board—that of the Regents of the University. The reasons are presented in the form of various newspaper articles which were published last year against a proposition of an opposite character—to abolish the present Department of Public Instruction and create a State Commission of Education, the affiliations of which would be political. Mr. Sexton has further offered two prizes of one hundred dollars each for articles or essays by women and similar productions by men in support of the proposed unification.

M. Hildebert Richard, of Avignon, France, relates that he experimented upon two adult geranium plants, both healthy and of vigorous growth, under like conditions of exposure, watering one (A) with well water and the other (B) with water containing a measured proportion of butylic alcohol daily. A kept on with its healthy growth. B, after four days of alcoholization, showed an enfeebled growth, with symptoms of jaundice, drowsiness, and intoxication; a special odor perceptible in all parts of the plant, partially burned spots, and melanosis and geotropism in the leaves.

In his papers on The Art and Customs of Benin, Mr. Ling Roth concludes that the art of that savage land consists of mixed elements, partly European forms which the native mind was prone to copy, partly introduced from other parts of Africa. It is characterized by boldness, freedom, clearness in execution, originality, and variety. Among the customs he mentions are the practice of human sacrifice and the sprinkling of the blood of the animals killed at the periodical sacrifices on the ivories and on the cast-iron or bronze figure-heads placed on the altars. When there was too much rain, a woman had a message saluting the rain god put into her mouth. She was then killed and set up in the execution tree, so that the rain might see.

Our scientific obituary list of the month includes the names of Sir William Dawson, the distinguished Canadian geologist, of whom a fuller notice is given in another place; Dr. Luther Dana Woodbridge, Professor of Anatomy and Physiology in Williams College, at Williamstown, Mass., of heart disease, November 3d, aged forty-nine years; Dr. Oscar Baumann, African explorer, geographer to the Austrian Congo Expedition of 1885, who made studies for the projected railroad from Tanga to Karog; Dr. F. Kuhla, botanical explorer, at Manáos, Brazil; Percy S. Pilcher, inventor of flying machines, from an accident while experimenting,

September 2d; Professor Hayduck, Privat Docent in Chemistry in Berlin; M. A. Snow, Instructor in Entomology in Leland Stanford Junior University, drowned October 10th in San Francisco Harbor; he had also been Instructor in Entomology in the Universities of Kansas and of Illinois, and was the author of several systematic papers on *Diptera;* Prof. J. B. Carnoy, of the Catholic University of Louvain, author of *Biologie Cellulaire* and of papers on the development of sexual elements, and founder of the journal *La Cellule*, at Schuls, Switzerland, September 6th; Dr. A. Ernst, Director of the National Museum, Caracas, Venezuela; Dr. Edward Petri, Professor of Geography and Anthropology in the University of St. Petersburg, aged forty-five years; Dr. Ottmar Mergenthaler, inventor of the linotype type machine, in Baltimore, Md., October 28th; and Dr. Henry Hicks, an English geologist and Lyell medalist, at Hendon, England, November 18th, aged sixty-two years.

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SOUTH SEA BUBBLES IN SCIENCE.

By Prof. JOHN TROWBRIDGE,
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THE advances in science lead to hopes of the sudden accumulation of gold, just as the discovery of new worlds led our ancestors to invest in many inflated enterprises of commerce and conquest. This older temptation has passed away, for there are no new worlds to discover, and this small globe has been practically staked out; but the mysterious domains of science are still illimitable, and afford vast opportunities for inflated schemes which have their prototype in the South Sea Bubble.

Let us refresh our memory of this surprising delusion. It arose in the reign of Queen Anne, nearly one hundred and eighty years ago, and when we consider the extent of the speculation and gambling which it caused and the number of those who lost everything and who consigned their families to bitter poverty, we are tempted to class it with those other calamities which preceded it and which afflicted England so heavily—the great fire of London and the plague. The South Sea Company claimed to have enormous sources of profit in certain exclusive privileges, obtained from the Spanish Government, for trading in their possessions in South America and Mexico; and it may be well for us in these times of the flotation of schemes for obtaining gold from salt water and from sands, of power from air and something more ethereal than air, to be reminded of the many bubbles that came into existence and burst at the time of the collapse of the South Sea Bubble.

The stock of the South Sea Company rose from one hundred to a thousand, and an army of future victims crowded the offices of

the company, anxious to invest in what they believed would suddenly enrich them. Indeed, all England seemed to go mad, and the craze of the time is reflected in the writings of Pope and Swift. Pope says:

> "At length corruption like a general flood
> Did deluge all; and avarice creeping on,
> Spread like a low-born mist, and hid the sun.
> Statesmen and patriots plied alike the stocks,
> Peeress and butler shared alike the box;
> And judges jobbed, and bishops bit the town,
> And mighty dukes packed cards for half a crown;
> Britain was sunk in lucre's sordid charms."

The rise of the great bubble was accompanied by the formation of hundreds of minor ones. Among these we will mention a few which are pertinent to the subject of this paper:

A wheel for perpetual motion. Capital, one million pounds.

For extracting silver from lead.

For the transmutation of quicksilver into a malleable fine metal.

Puckles Machine Company, for discharging round and square cannon balls and bullets, and making a total revolution in "the art of war."

For carrying on an undertaking of great advantage, "but nobody to know what it is."

It is estimated that the proposed capital for floating these and similar schemes was three hundred million pounds. We find, in the annals of the time, that the Duchess of Marlborough persuaded her husband, John Churchill, the great general, not to increase his holdings, and to sell his shares; he, like a sensible man, took a sensible woman's advice and made one hundred thousand pounds. When we come to speak of the connection of women with modern delusions, we must remember this act of one of their sex.

At this time, nearly two hundred years after the singular outbreak of chimerical projects of Queen Anne's reign, we can match some of these bubbles almost exactly; for have we not had the Keeley motor, the extraction of gold from salt water, and is there not great activity in making the wonder of the public over some advance in science a source of money-making? The unscientific person is certainly open to a new danger in the increasing tendency to promote enterprises based upon some new scientific discovery, and it behooves the followers of science to suggest a remedy for this growing evil. I shall endeavor to do my part in this paper in pointing out the necessity of some oracular medium—a scientific oracle of Delphos—to which the common man can repair and get trustworthy information, for it is a melancholy fact that such infor-

mation can not be obtained from the daily press or from the literary magazines of the time.

Many of our newspapers draw such an income from their advertising columns that the editors are unwilling to print any criticism which would lead to the restriction of this source of gain; thus if a company promoting a scientific bubble should advertise liberally in a leading newspaper, the editors are usually loath to insert an article upon the scheme, for the printing of the criticism might lead to the withdrawal of the advertisement. It is possible that the editors of such daily papers have not overmuch confidence in the judgment of scientific men, for have not the latter often been mistaken? There was Lardner, who prophesied that steamships could not cross the Atlantic, but we must remember that Lardner was not a scientific man; he was a popularizer of science, and never made a scientific investigation. It is said that there have been college professors who have denied the possibility of sending messages under the ocean. This I also doubt, for I am a witness in the flesh of the way such stories can arise. Not long since I was invited to speak before a commercial club, and the presiding officer, in introducing me, remarked: "The professor will now address you on the advances in electricity. When I was in college I well remember his describing an electric motor and his remark that it would never become a practical invention." There was, of course, laughter, and the president sat down with a comfortable air of having made a point. The professor pointed out that the presiding officer graduated before he became professor in the university, and before the Gramme machine and the electric motor were invented. Nevertheless, the world loves to believe in the inaccuracy of the accurate, and even a sophomore takes infinite delight in discovering arithmetical mistakes in an edition of Newton's *Principia.*

I mention this proneness to believe that scientific men are apt to be mistaken, for it is a blame laid at their doors often by the promoters of scientific bubbles, and for a very easily understood reason, and the editors of newspapers and literary magazines can ease their consciences after publishing sensational scientific articles by reflecting on the fallibility of the followers of science. Lawyers and judges, too, make their mistakes; nevertheless, we continue to resort to them for advice; and few editors, I imagine, would dare to publish a legal opinion without consulting an authority in law. Yet we read every day so-called scientific articles in newspapers and magazines which have evidently never been submitted to competent critics. Have we not read statements of the possibility of exploding powder magazines on board ships by electric waves; of the manufacture of liquid air without the expenditure of energy;

of electricity direct from coal; papers on the nebular theory, more nebulous than any nebula yet discovered? When we read a broad sheet in the morning paper setting forth a glowing scheme to manufacture power out of nothing, to what oracle can we repair to ascertain the truth? It is true that common sense might lead the reader to reflect that when he is told that the shares can now be obtained for five dollars, but in a short time they will be advanced to ten dollars, and now is the time to invest, that such good things are quickly taken up without the necessity of advertising. When the morning mail brings a prospectus of a company formed to make diamonds by electricity, a company with ten million dollars capital (why not one hundred millions?), to whom should one go to allay the fever of sudden gain? While men and women will carefully consider which line of steamships to Europe is the best equipped with engines, the efficiency of which depends upon the laws that prove the impossibility of perpetual motion, they enter at the same time upon schemes to obtain power without the consumption of work.

We are indeed confronted with the curious fact that even so-called intelligent people can be led to believe that what we have learned in regard to the working of Nature may be thrown aside, and that some new and unrelated laws may rule supreme. Thus we have what is called Christian Science, one of the intuitional sciences which may be said to add a new peril to matrimony. We find cultivated men believing that a government can make money by pronouncing silver equal to gold. Thus there are those who fondle their delusions and those who bank upon credulity. Education seems to be ineffectual with some temperaments; on the whole, however, it has a saving grace, and there are undoubtedly a number in the community who would welcome a source of scientific authority which might answer for them just as the Times does in political and economic questions to an Englishman. The American has especial reason to fear scientific bubbles, for our patent laws make it comparatively easy for promoters to make a great show of vested rights. One method is to build an imposing plant, with powerful dynamos and with a multiplicity of electrical devices, and to capitalize for an enormous sum an expensive plant in sight with millions in patents of very little value. The proposed investor is taken to see the great plant; its magnitude appeals to his reverence for size, and his pocketbook is soon at the service of the promoter. Another method is to select some scheme which is on the borderland between physics and chemistry, such as the electrolytic method of obtaining gold from salt water. There is a minute quantity of gold in salt water, and the chemist, thinking

that electricity might afford an economical method of treating large quantities of water, is reticent in regard to such a scheme, while the electrician, ignorant of chemistry, is ready to concede that the chemists may have found a cheap extractor, so the promoter can play the chemist against the electrician, and there is no arbitrator in sight. The American is peculiarly in peril from the absence of a large body of men trained in technical science, such as exist in Germany. He also has been unduly excited, and his desire for love of sudden wealth stimulated by phenomenal successes. The commercial triumph of the telephone has led to a multitude of scientific bubbles, and has resulted, like the discovery of gold in the Klondike, in a rush into electrical schemes which have been held up to a hungry crowd of victims as second only to the Bell telephone.

While the telegraph and the telephone can prevent speculations like the South Sea Bubble in a great measure, for such schemes were much aided by a lack of a general dissemination of intelligence, and this lack is supplied by a quick interchange of knowledge, they bring their own peculiar peril, for they are examples of what profit may be reaped from discovery in the world of science. The commercial enterprises of the world have been brought within reach of the many by the telegraph and telephone. They no longer belong to the few, while the successful working of the field of science is still confined to a minority and the general public; even the cultivated people are very ignorant of the approaches to the New El Dorado. No bogus land scheme or salted mining enterprise can be kept in existence to-day for a long period; but the Keeley motor, with its ethereal vibrations and its pseudo-molecular motions, was limited in activity only by the life of the promoter. Instead of the alchemists we have the seekers after power, which costs nothing, and in the train of the honest inventor there are unscrupulous promoters ready to capitalize any remarkable new fact or discovery which attracts public attention.

I have mentioned the influence of the first Duchess of Marlborough in inducing her husband, the great duke, to sell out his shares in the South Sea Bubble when they had risen to a high value because this example of discrimination and prudence in a woman supports one in the belief that all women are not prone to invest in women's bank schemes, in Keeley motors, or in enterprises for "carrying on an undertaking of great advantage, but nobody to know what it is." One of my friends recently visited the office of a company which proposed to produce power without the expenditure of a due amount of energy, and found among those anxious to invest a woman who said that she had just received a dividend from the company for extracting gold from salt water, and she was

anxious to invest it in the new power company. The dividend was the result of a liquidation of the Gold from Sea Water Company, and represented half of her original sum. She had come out of one delusion with a loss of half of her property, and was now ready to enter another one with the remaining half. It was an old-fashioned notion that women should be kept in ignorance of business, for business knowledge, it was thought, was the concern of the husbands. This notion prevails still in some quarters, and there may be some connection between the number of women in Christian Science temples and their lack of education in practical matters, or in what may be called the legal business habit—a habit which weighs the probabilities of this and that, and leads to ways of exact thinking.

One of the remedies for this proneness of women to invest in scientific bubbles, to invest money on faith, is the lack of exact training, which is not acquired by them either in private schools or colleges. The classes of philosophy and psychology in women's colleges are crowded, while those in the exact sciences have only handfuls. This remark also applies to the students in men's colleges, and we realize in this respect how closely college women imitate college men. They follow the latter also in the habit of taking lecture courses, a custom which increases vagueness, inaccuracy of thought, and looseness of statement. This choice of studies by the young women in their colleges is a serious question for mankind, in view of the speculative spirit which the feminine sex show toward scientific bubbles and schemes which promise an inordinate rate of interest; for the graduates of these colleges will become teachers of youth, and if not teachers they have an influence upon the coming citizen during his formative period. As teachers they will far outnumber men teachers, and they are fast coming into competition with men also in the routine of business offices and in certain positions in commercial houses. In these activities they will need a balance of judgment, exactness of thought, and business habits. They should be given a sufficient knowledge of the elements of physical science to know that power can not be created from nothing, and that the great mass of our knowledge of mechanics and of the relation of electricity to mechanics can not be overturned by any new discovery. Whatever is discovered must be related to what has preceded it. This is a characteristic of a science, and this is what distinguishes it from a delusion—namely, the great body of related facts put upon a mechanical basis, so that any fact can be substantiated and any phenomenon repeated. When this latter test is applied to many of the isms of the day they fade into thin air, and young women need especially to be taught to apply such

a test. It would seem as if the present choice of study by women students tended to intensify vagueness of thought rather than to correct it, to keep them in ignorance of business habits rather than to educate them in the balance of judgment on economic questions.

Women are born speculators, and are peculiarly prone to invest money and heart in bubbles. Being the power behind the throne, they can carry men into action, and it seems to me that especial attention should be paid in women's colleges to the studies that cultivate accurate thought and business methods. A certain amount of the study of scientific methods and a study of common law might take the place of the study of philosophy, psychology, and biology, certainly in the first years of a woman's college course, for psychology and biology are studies which demand long scientific training and maturity of thought. Recently I heard the following conversation at a bank in Cambridge. The cashier was speaking with a young lady: "Miss ——, your friend has overdrawn her account three hundred dollars, and you say she has left Cambridge." "Yes, the trouble with Jane is she is too much educated." A long residence in a university town makes one wary of educational theories, but the proneness of women to invest in women's banks and bogus trust companies certainly seems to need a corrective in a new college curriculum. Men can indulge in delusions and can recover mental balance, and perhaps their fortunes; but women are apt to become bankrupt permanently. Their experience in business delusions is similar to that in affairs of the heart. Washington Irving says of this feminine attribute:

"She sends forth her sympathies on adventure; she embarks her whole soul in the traffic of affection, and if shipwrecked her case is hopeless, for it is a bankruptcy of the heart."

More mathematics and science, and less philosophy and psychology, might correct that vagueness of thought which leads both men and women into delusion.

Now for our other remedies. Shall we have an academy which shall issue storm warnings of scientific bubbles? I fear that the influence of academies is waning, and that the conviction that there are as many good men outside of the academy as inside would militate against their dicta. We could have courts of scientific appeal, with judges appointed by the State to sit on scientific questions of perplexity, and to sift expert opinions. Such a constitution of scientific courts might be a good thing in several ways—a saving health to the public. The college professor would certainly be greatly relieved of endeavors of promoters to use the name and reputation of the professor's university, and incidentally the little his own name might add. This remedial solution is not in sight,

and we must direct our vision in another direction. We know that the newspaper can not serve us, for we seek to kill sensations, and it seeks to live on them. We are bound to turn to some journal or periodical which will publish only what it considers sound science and will eschew sensational science; a journal which, just as the London Times is regarded as the authority on political and economical questions, will be looked up to as an authority on matters of science.

In order, therefore, to protect the public against scientific bubbles we must impress upon both men and women the fact that an education in science is desirable, and is becoming more important as the world grows older; but until a scientific education becomes more general, it is important that there should be some scientific oracle of Delphos, and I can not think of any better than a well-managed scientific journal, the editors of which will seek for the best information on scientific questions which interest the financial world. When it is known that such a journal admits to its pages nothing that is sensational, when it is realized that the best specialists contribute to it, surely it will become a saving help in times of trouble.

WHAT MAKES THE TROLLEY CAR GO.

By WILLIAM BAXTER, Jr., C. E.

II.

IF the successful operation of a street-railway car by mechanical power depended wholly upon the ability to produce a motor of sufficient capacity to do the work, the problem would be an easy one to solve, and would have been solved long before the advent of the electric motor. Mere ability to furnish the necessary power, however, is not enough to meet the requirements. As already shown, the mechanism must be light, strong, compact, simple, and so well protected that it can not be injured except under abnormal conditions. In addition, speed-controlling devices must be provided whereby the velocity may be changed at will and in the shortest possible time, and with as nearly absolute precision as possible. This controlling mechanism must also be so arranged that the direction of motion may be varied with the greatest certainty and as rapidly as may at any time be required. The way in which these

Note.—The illustrations of railway generator and switchboard were made from photographs kindly furnished by the Westinghouse Electric and Manufacturing Company.

For the photographs of the electric truck and car controller we are indebted to the courtesy of the General Electric Company.

results are accomplished in an electrically operated car can be understood from Figs. 18 and 19, which are line drawings, in a simplified form, of an ordinary trolley car. Fig. 18 is an elevation showing the outline of the car body and the wheels in broken lines, while the motors and the wires through which the current is conveyed thereto are drawn in solid lines. Fig. 19 is a plan in which the outline of the car floor and the platforms is represented in broken lines, the solid lines being the motors and connecting wires.

In almost every instance railway cars are provided with two motors, as shown at *M M* in these two figures. This arrangement is adopted not because one motor can not furnish all the power required, but simply for the purpose of making the equipment more reliable. Everything of human make is liable to fail; hence if only one motor were used there would be more or less liability of its giving out at a critical moment, and then the car would be helpless. If two motors are provided, should one give out the car would not be disabled, for the remaining machine would be able to run it to its destination. In order that this result may be successfully accomplished, each motor is made of sufficient capacity to run the car without being overtaxed, unless the load is abnormally large; but even under the latter conditions the machine will in ninety-nine cases out of a hundred withstand the strain. Some roads, in small towns, where the traffic is light and the expense must be kept down to the lowest point, use single-motor cars, so as to effect a saving in first cost. This course, however, is very seldom followed, except in places where there are no heavy grades or where there is very little probability of the loads becoming excessive, except at rare intervals. If the cars are provided with a single motor, when one becomes disabled from any cause it has to wait until overtaken by the car behind it, so that it may be pushed by the latter to the end of the road.

The electric current for operating the motors is generated in a power house that is located at some convenient point along the route. The current is conveyed to the moving cars by means of a trolley wire, which is marked *T* in the drawings. Unless the road is very small and operates but a few cars, this wire will not be sufficient to carry all the current, hence in most cases there are a number of supplementary wires, which are called feeders. These wires are carried along on poles, and at proper intervals are connected with the trolley wire *T*. The electric current passes from the trolley wire through the motors on the car, and thence to the rails *R*, and through these, and also through the ground, back to the power house. The exact path of the current is as follows:

From the trolley wire, through the trolley pole *t*, to the fixture on top of the car which holds the latter. From this fixture, as shown by the heavy full line, the current passes to *a*, which is a switch located under the car hood overhanging the platform. From this switch the current passes to a similar one, marked *b*,

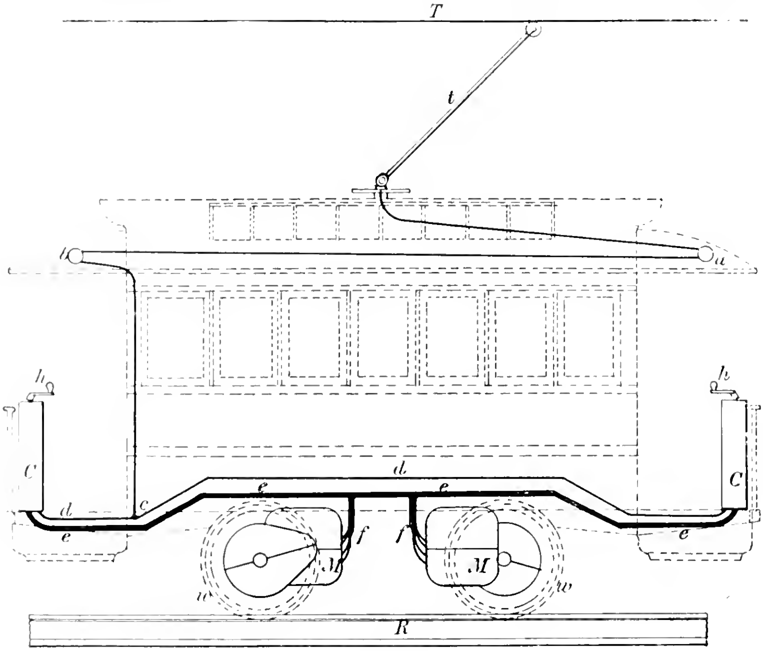

Fig. 18.

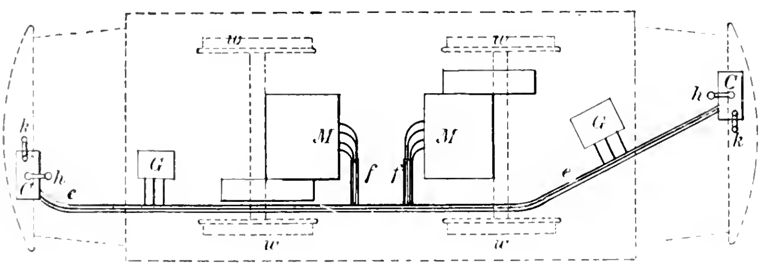

Fig. 19.

Figs. 18, 19.—Outline Elevation and Plan of Electric Railway Car, showing Location of Motors, Controlling Switches, and Connecting Wires.

located in a like position at the other end of the car. These two switches are called emergency switches; they are provided simply as a safety device, and are used only when the main switches get out of order and the motorman can not turn the current off in the regular way. From the last hood switch *b* the current passes to

the bottom of the car, where it enters the wire *d d* at the point *c*. This wire *d d*, as will be seen, runs in both directions, and ends in the stands *C C*. These latter are the controlling switches, and are provided with a handle *h*, by means of which the current is turned on or off from the motors, and is directed through them in such a way as to make the car run in whichever direction may be desired. From the controllers *C C* several wires are run under the car, as shown at *e e e*. These wires are generally bunched into one or two cables, but they are kept separate from each other by means of strong insulating coverings. Four wires lead into each motor, and three or four into each of the boxes marked *G G*. If the motors were required to run in one direction only, then two wires would be sufficient to convey the current to them; but as they have to run in either direction, at least three wires are necessary, but in almost every case four are used, as the results obtained thereby are more satisfactory. The boxes *G G* are called rheostats, and are simply devices through which the current is run so as to reduce the speed of the car, and also for the purpose of graduating the strength of the current that passes through the motors in the act of starting. These rheostats are very seldom in use when the car is in motion, because it is a waste of power to pass the current through them. After the current has passed through the motors it enters the ironwork, and thus gets into the car wheels and finally to the track.

The lines drawn in Fig. 18 to indicate the position of the wires in the car do not show their actual position, but only the general direction they follow. From the trolley base to the first hood switch the wire, as a rule, is run along the car roof on one side of the ventilator, and the wire leading from the first to the second hood switch occupies a corresponding position on the opposite side of the roof. From the last hood switch, *b*, the wire is run down one corner of the car body, being either within the car body, or, if not, so covered by moldings as to not be reached by the hands of passengers. The wires *d* and *e* are generally run under the car, and are firmly secured to it by means of suitable fastenings.

The controlling switches *C C* are provided with one and sometimes two handles, one of which is used to regulate the speed of the car and stop and start it, while the other is for the purpose of reversing the direction in which it runs. The handle *h* is for the purpose of regulating the speed, and by means of *k* the direction of motion is changed. Before *h* is moved from the inactive position *k* is turned so that the car may run either forward or backward, as may be desired; then, when *h* is moved, the car will start, and by varying the position of *h* the speed can be changed. If it is de-

sired to reverse the car, *h* is brought back to the stop position, *k* is shifted to the reverse motion, and then *h* is again turned to the running position. When the controlling switch is provided with only one handle this is turned in one direction to run the car ahead, and in the opposite direction to run it backward, the graduations in velocity being obtained by placing the handle in positions intermediate between the stop position and the highest speed position.

As will be noticed, the wire *d d* branches at *c* and runs in both directions. Now, when the controller handles are both turned to the stop position the current from the trolley can get no farther than the ends of *d* in either switch, but if one of them is turned to the running position, the current at once passes to the wires in the cable *e e e*, and thus to the two motors. If the switches *C C* are in proper working order and there is no disarrangement of the wires leading to the motors or those within the latter, the current will obey the movements of the handle *h*, but under other conditions it may not. If such an emergency arises, the motorman reaches up to the hood and turns the safety switch *a* or *b*, and thus cuts the current off.

The force with which the motors turn the car wheels around depends upon the strength of the current; this is owing to the fact that the magnetic force is increased or decreased by variations in the current strength. If the current is doubled the magnetic force of the armature is nearly doubled, and so is that of the field magnet, therefore the pull between the poles is nearly four times as great. From this it will be seen that the force with which the car is pushed ahead can be increased enormously by a comparatively small increase in the strength of the current. If the current strength is doubled, the propelling force is practically quadrupled; and if the current is increased four times, the propelling force is made nearly sixteen times as great.

The speed at which the car runs depends upon the force that impels the current through the wire, and which is called electro-motive force. The greater the electro-motive force, the higher the velocity. If the current passes from the wires in the cable *e e e* through each motor separately, and thence to the rails *R*, each machine will receive the effect of the whole electro-motive force of the current; but if after the current has passed through one motor it is directed through the other, then each machine will be acted upon by only one half the electro-motive force, and, as can be seen at once, the velocity in the first instance will be twice as great as in the last. This fact is taken advantage of in regulating the speed of the car, and controlling switches arranged so as to direct the current through the motors in this way are designated

as belonging to the series parallel type, the name being given from the fact that when the car is running slow, the current passes through the two motors in series—that is, through one after the other; but when the motors are running fast, a separate current passes through each machine.

If, when a car is running, the controlling switch is turned to cut the current off, the effect will be that the speed will gradually

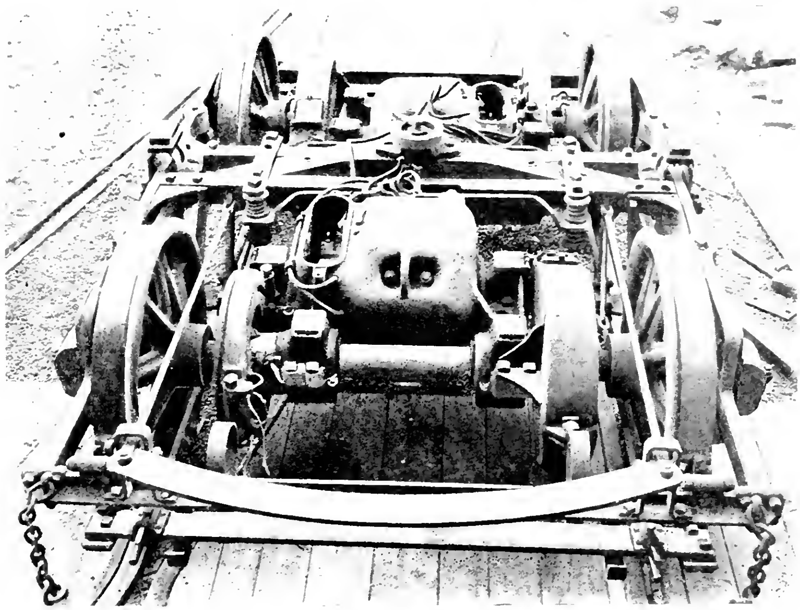

Fig. 20.—View of Electric Railway Truck with One Motor on each Axle and provided with Magnetic Brakes.

reduce; but if it is desired to effect a sudden stop, it becomes necessary to check the headway by means of a brake. For this purpose the hand brake ordinarily used on all types of cars is employed, but magnetic brakes are also used in some cases. Fig. 20 shows a car truck equipped with two motors and magnetic brakes, one on each axle. Looking at the front end of the truck, the brake is seen on the left side of the axle, between the motor bearing and the car wheel. The larger drum, on the right side, is the casing within which the gear wheel and pinion are inclosed. These magnetic brakes are operated by a current generated by the motors, and not by that of the main line. As was explained in the first article, an electric motor can be made to act as a generator of electric current by simply reversing the direction in which the armature revolves. If we do not desire to reverse the direction of rotation, the result can still be attained by reversing the direction in which

the current passes through the armature coils. It is evident that the direction of a car motor can not be reversed at the instant that it is desired to have it act as a generator—that is, when it is desired to put the brakes on; hence the direction of the current through the armature is reversed.

When a car is provided with magnetic brakes, the controlling switches are so made that when the handle *h* is moved back to the stop position it disconnects the motors from the trolley wire and at the same time connects them with the magnetic brakes in such a manner that they will act as generators and thus send current through the coils of the latter. In order that the force with which the brakes are applied may be graduated, the controlling switches are arranged so as to be moved several steps back of the point which in the ordinary type of switch would be the final stop position. When the handle *h* is placed on the first brake position the current generated by the motors is not very strong, and as a consequence the force of the brake is light, but sufficient to bring the car to a stop in a reasonable distance. If a quicker stop is desired the handle is moved to the second, third, or fourth brake position, thus increasing the retarding force as much as may be desired. Magnetic brakes are very desirable, as they save the car wheels, and furthermore afford an additional safety in cases where it is necessary to arrest the speed instantly.

The position of the motors with reference to the truck and car wheels is very well shown in Fig. 20, and also the manner in which they are held in place. The covers of the openings through which access to the commutator brushes is obtained are removed from both motors, and in the forward one the top of the commutator and one of the brushes can be readily seen. The manner in which the motors are suspended from the truck is not the same in this figure as in those previously shown, but this is simply because the machines are not made by the same concern, and each manufacturer has his own design.

Fig. 21 shows the appearance of the interior of the controlling switches *C C*, Figs. 18 and 19. It will be noticed that there are two upright shafts, the ends of which project above the top of the box. The handle *h* is placed upon the shaft to the left, and *k* on that to the right. The first is the main controller, and the other is the reversing switch. It will be noticed that the main controller shaft carries a number of circular segments of different lengths; these are so disposed that they come in contact with suitable stationary pieces as the handle *h* is turned around, and thus vary the path of the current through the motors and the rheostats in the manner required to effect the desired changes in the velocity

of the car. The reversing shaft is also provided with a number of segments, but these are not so easily seen, although they can be discerned on close examination. The wires from the cable *e e e* and also wire *d d* are attached to the stationary pieces with which the segments carried by the two shafts make contact when the latter are moved around by the motorman. These wires can be seen back of the main switch shaft, and also above the board located

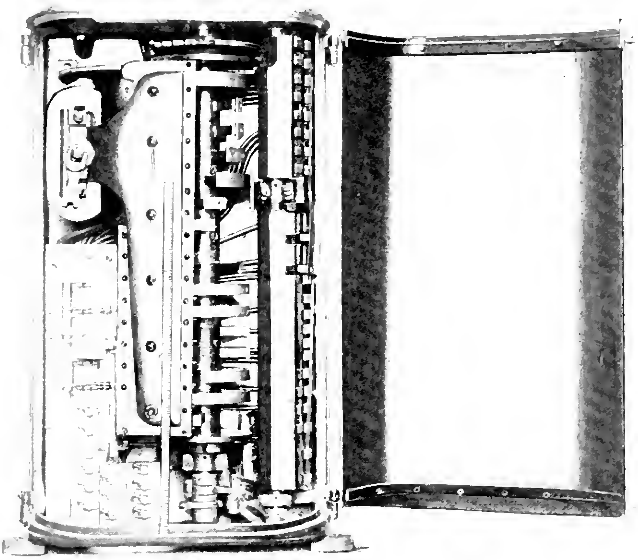

FIG. 21.—VIEW OF INTERIOR OF CAR CONTROLLER.

at the lower left-hand corner. All these wires enter the controller through an opening in the bottom.

In addition to the apparatus shown in Figs. 18 to 21, electric cars are provided with a safety fuse and a lightning arrester, the object of the latter being to protect the motors from the destructive effects of lightning strokes. The object of the safety fuse is to protect the motor from injury when the current becomes too strong. An electric current in passing through a wire generates heat, and the stronger the current the greater the heat. If the wire is large and the current weak, the heat developed may be insufficient to raise the temperature to a noticeable degree; but, on the other hand, if the wire is small or the current very strong, the heat generated may be capable of raising the temperature of the metal to the fusing point. In fact, the incandescent lamp operates upon this principle; the carbon filament is traversed by a current of a strength sufficient to heat it to a point where it becomes intensely

luminous, and sometimes, through accident or otherwise, the current becomes strong enough to melt the filament, and then the light goes out. In an electric motor it is not necessary to raise the temperature of the wire to the melting point to do serious injury; in fact, if the heat is sufficient to char paper or cloth, the machine will be rendered useless until suitable repairs are made. The insulation of the wire coils is made principally of cotton, which is a very good electrical insulator in its natural state, but when carbonized by excessive heat it becomes a conductor. As soon as it becomes a conductor the current is no longer confined to the proper channel, but cuts through the insulation to find the shortest path through the machine. If safety fuses were not provided the danger of destroying the insulation of the motors and thus disabling the car would be decidedly great, for, as already said, the motors can not be stalled with an overload, the only effect produced being a reduction in the speed and an increase in current strength. Now, if there were no way of limiting the increase in current strength the motors, if greatly overloaded, would continue to operate until the insulation gave out. The safety fuse is simply a piece of wire of such size that it will be melted by a current that the motors can carry without being injured; hence when the current strength reaches a point where the safety of the apparatus is endangered the fuse melts and thus breaks the circuit and stops the further flow of current. Fuses are generally made of an alloy that melts at a low temperature, so that the molten metal may not set fire to anything upon which it may fall. These easily fused alloys are inferior to copper as electrical conductors, and on this account the fuse wire is as a rule much larger than that wound upon the motors, which fact makes its action somewhat mysterious to the uninitiated; but whatever its size may be, it is so proportioned that it will melt before the current rises to a strength that would injure the motor coils.

The manner in which the electric current generated in the power house reaches the motors is illustrated in Fig. 22. In this figure four tracks are shown, which may be taken to represent roads running in as many different directions. The three squares at the left side represent generators located in the power house. The circles *a a a* represent switches, by means of which the generators are connected or disconnected from the trolley lines. *A* and *B* represent heavy metallic rods, generally made of copper, with which the generators are connected by means of the switches *a a a*. These rods are called bus bars. The circles *b b b b* represent switches by means of which the current is turned on or off from the several tracks.

Electric currents must always circulate in closed paths—that is, the current that starts out from a generator must return to it, and the amount coming back is the same as that which leaves. The action of an electric generator can be understood by comparing it with that of a water pump pumping into a pipe which runs around from the delivery end to the suction. With such an arrangement it can be seen that the action of the pump would be to keep the water in circulation, but the same water would be pumped through the pump and the pipe all the time. With an electric

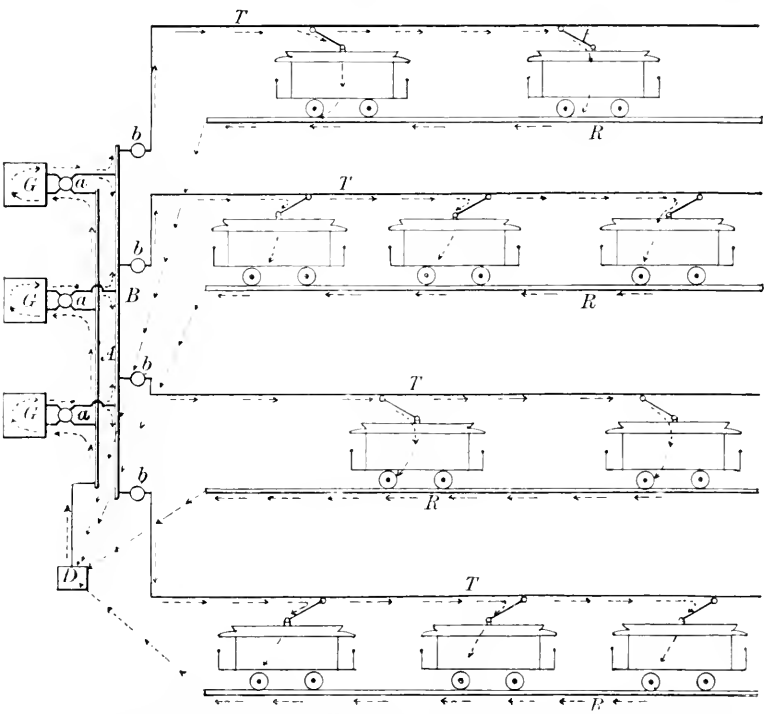

FIG. 22.—DIAGRAM ILLUSTRATING THE MANNER IN WHICH THE ELECTRIC CURRENT FLOWS FROM THE GENERATORS TO THE CARS UPON THE TRACKS.

generator the action is the same, and in Fig. 22 the current flowing along any one of the tracks follows the course indicated by the arrows. The currents pass out to the several tracks through the trolley wires *T T T T*, and return through the tracks *R R R R*. The bus bar *A* is connected with a plate *D*, which is imbedded in the ground, and is also connected with the ends of the rails *R R R R*. Suppose for a moment that the two lower generators are out of service, their switches *a a* being turned so as to disconnect them from the bus *A*, and, further, suppose that the three lower *b* switches are open, so that the current can only pass to the

upper track; then the top generator will feed into the top road only. Tracing the path of the current under these conditions, we find that it will start from the upper side of the generator through the *a* switch to the *B* bus, and thence to the trolley wire at the top of the figure. On reaching the first car a portion of the current passes to the track *R*, the amount being dependent upon the speed of the car and the load. Why the whole current does not follow this path generally puzzles the layman, but the explanation is that the motors hold the current back, and only allow as much to pass through them as is necessary to perform the required work—that is to say, the current flowing through each car is not controlled by the generator or by the force of the current, but by the requirements of the motors. The amount of current delivered by the generator is governed by the demands of the motors. The current that does not pass through the first car goes on to the second one, and if there were more cars there would be current left in the trolley wire to supply them. After passing through the motors of the two cars the current returns through the rails *R* to the plate *D*, and thus to bus *A*, from which it enters the lower side of the top generator. It will from this explanation be seen that the action of the generator is simply to keep the current circulating. If two of the generators are connected with the bus bars *A* and *B*, the current required by the motors will be delivered by the two machines, and if the three generators are placed in service the current will be divided among them.

When two or more generators are used, it is necessary to provide means to prevent the current from dividing unequally between them; if this were not done, one machine might do nearly all the work, while the other one would be practically idle. The means employed to accomplish the result is simply an additional bus bar, which is called an equalizing bus. We will not undertake to explain the principle upon which this arrangement acts; it is sufficient to say that by such means the work can be distributed in amounts directly proportional to the capacity of the generators, so that if one machine is very much larger than the others it will take a portion of the load corresponding to its size. In order that these results may be attained it is necessary to properly adjust the several generators, and as no machine can be made to work with the accuracy of perfection, the work will not be distributed in true proportion for all conditions of load; thus if the generators are adjusted so as to each take its proper share when all the cars are in operation, one machine may do too much or not enough when only one half the number are running, but the excess or deficiency will not be more than a few per cent unless the adjustment is very defective.

Electric generators for railway work are made in all sizes, from those only large enough to operate four or five cars to others capable of furnishing sufficient current for thirty or forty or even more. Small generators are made so as to be driven by a belt running over a pulley mounted on the end of the armature shaft, or they may be arranged to be connected to the end of a steam-engine shaft, and thus become what is called direct connected machines. Large generators are almost invariably of the latter type. A machine of this class is illustrated in Fig. 23. The driving engine is shown at *E*, the cylinder being in the background and the crank toward the front, the shaft being clearly seen at *S*, while *F* is the

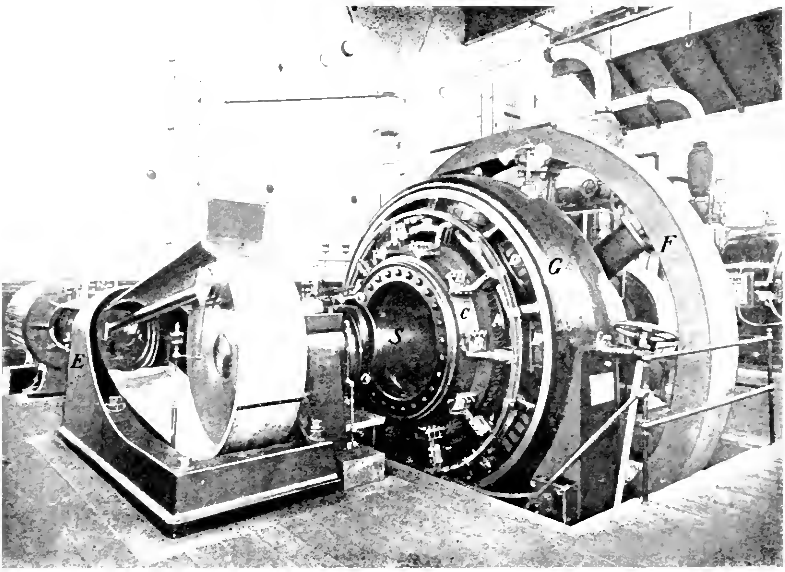

FIG. 23.—LARGE-SIZE DIRECT CONNECTED ELECTRIC RAILWAY GENERATOR.

fly wheel. The generator is mounted directly upon the engine shaft, between the bearing at the crank end and the fly wheel. The large ring marked *G* is the field magnet ring, and at *D D D* the field coils are shown. These coils are equally spaced all the way around the circle. The commutator is marked *C*, and the commutator brushes are located at *B B*. The armature can not be seen very well, as it is covered by the brush holders and their supporting frames, but it is located within the ring *G* in the position designated by *A*. This machine is one of a number used to operate the roads of Troy, N. Y., and is of about one-thousand-horse-power capacity, which is enough to furnish all the current required to run sixty or seventy cars.

The switches *a a* and *b b*, shown in Fig. 22, and the bus bars

A B, are mounted upon a large panel, made of marble or slate, called a switch board. These switches are sufficient for the purpose of turning the current on or off any track or for connecting and disconnecting the generators, but for the successful operation of the plant it is necessary to have other devices by means of which the strength of the current may be ascertained, and also the electro-motive force. It is necessary to provide each generator with means for varying the electro-motive force of the current it generates, otherwise the load could not be properly equalized between the several machines. All these different devices are located upon the switch board, so as to have them in an accessible position. A railway switch board, arranged for four generators and a large number of distributing circuits, is shown in Fig. 24. The four generator switches are shown at *a a a a*, and the circles marked *R*, directly under them, are the devices by means of which the electro-motive force of the current is regulated. These devices are called field regulators, from the fact that their office is to regulate the strength of the field magnets of the generators, making them stronger to increase the electro-motive force and weaker to reduce it. The part seen upon the front of the switch board is not the regulator proper, but only the handle and the contact points over which this swings. The instruments marked *A A A A* are for measuring the strength of the current of each individual generator, and are called ammeters. The instruments marked *V V V V* are for the purpose of indicating the electro-motive force of the currents of the several generators, and are called voltmeters. *Ag* is an ammeter used to measure the strength of the total current, and *Vg* is a voltmeter that indicates the electro-motive force of the current passing out to the cars on the various lines. The ammeter *Ag* is not an actual necessity, for the strength of the total current can be ascertained by adding the readings of the four instruments connected with the generators, but it is a convenience, as it saves the trouble of performing the addition. The voltmeter *Vg*, however, can not be regarded in this light; in fact, its presence is decidedly serviceable, for it indicates the average electro-motive force of all the generators; therefore if any one of the instruments *V V V V* is higher or lower it shows at once that the generator to which it is attached is out of adjustment and not doing its proper share of the work. The switches *b b b*, by means of which the current is turned on to the several external circuits, are shown at the extreme end of the switch board.

The instrument marked *W*, located between the *a* switches, is called a wattmeter, and its office is to indicate the amount of power furnished by the generators. This instrument is not always used,

as it is a convenience but not a necessity. It can be seen at once that whether it is used or not, the amount of power required to operate the roads will be the same, but it is thought by most railroad managers that it is desirable, for then the relation between the coal consumed and the power developed can be seen; and if the showing is not as good as it should be, the engineer can remind the firemen that they are not exercising as much care in feeding the boilers as they should. Considered in this light, the wattmeter acts as a check to wastefulness on the part of the employees.

The instruments marked *C C C C* serve the same purpose in connection with the generators as the safety fuses do with respect to the car motors; they are electro-magnetic devices used to open

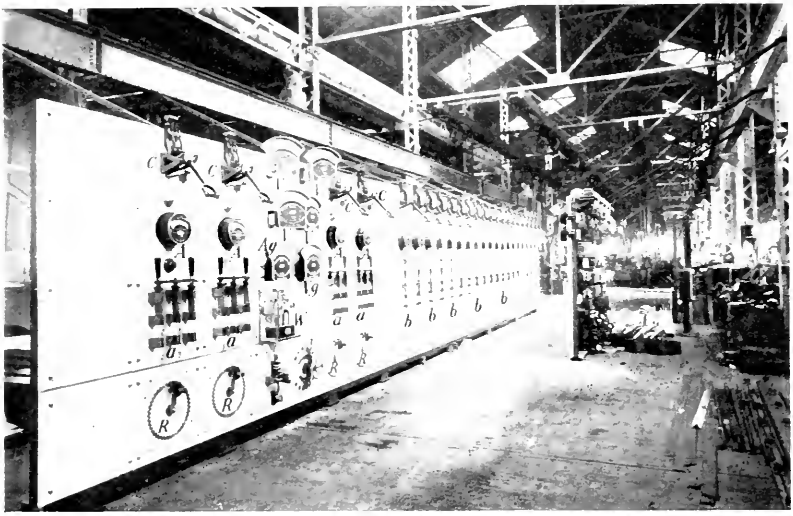

Fig. 24.—Electric Railway Switchboard.

the generator circuits whenever the current reaches a strength that is sufficient to injure the machine. These devices are called circuit breakers. As will be noticed, there are four located directly above the four *a* switches, and, at the farther end of the board, a large number located directly above the *b* switches. The latter act to open the individual circuits when the currents flowing in them become too strong, and the former are controlled entirely by the current of the generator circuits. A circuit breaker is more reliable than a safety fuse, because it acts quicker. With the fuse the current must act for some time before it can melt the metal, as a sufficient amount of heat can not be generated instantly. With the circuit breaker, however, the action is instantaneous, for as soon as the current reaches the predetermined strength the magnetism of the

operative parts of the device becomes sufficiently strong to cause it to act. A circuit breaker is simply a switch that is arranged to be opened automatically by the action of a magnet, instead of by the hand of the operator. The switch part of the apparatus is held in place by a catch that is set much after the fashion of the catch in a mouse trap—that is, so that the least pressure will disengage it. A strong spring acts to throw the switch open, and as soon as the catch is tripped by the actuating magnet the force of the spring comes into action and the circuit is opened.

The circuit breaker is a very valuable apparatus, for it frequently happens that, through delays of one kind or another, a large number of cars concentrate at one point on the road, and, as all the motormen are anxious to make headway, they all start up at once at the first opportunity. If there were no circuit breakers at the power house the result would be that some of the generators would be greatly overloaded and perhaps disabled; but, owing to the presence of the circuit breakers, the actual result is that the circuit is broken, and then the motormen have to wait until the current is turned on again. If too many of them try to start their cars at the second trial the current will again stop. After two or three ineffectual efforts have been made to start all the cars together the motormen will conclude to go easy, and set a few in motion at a time. In this way the cars will become more evenly distributed along the line, and the demand for current at the point of blockade will reduce to the normal amount, or nearly so, and the running of the cars will continue without further interruption, for the current drawn by the motors having been reduced to the average amount, the circuit breaker will cease to act.

The bus bars and all the connections between them and the generators and external circuits, as well as with all the instruments, are located behind the switch board. All these connections are so secured that they can not come in contact with each other except where contacts are required; care is also taken to prevent any connection being made with the iron framing that supports the marble slabs. The front of a switch board is generally very attractive, the surface being of highly polished marble, while all the switches and instruments are finely finished and, as a rule, of decidedly ornamental design.

The switch board might be looked upon as the fountain head from which the entire operation of an electric railway system is controlled. By the movement of one set of switches upon it the generators are thrown in or out of service, and by the movement of another set of switches the several branches of the road are rendered active or inactive.

IS THE CHRISTIAN RELIGION DECLINING?

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THE question whether the Christian religion is declining is agitating the public mind in some measure at the present time. This is due to the many changes that are taking place in the forms of religion, the types of doctrine, and the methods of action in the numerous religious organizations which bear the name of Jesus Christ. Are these changes symptoms of disease and decay in the Christian religion, or are they evidences of renewed vitality and enlargement by growth? It is quite evident that many things which have been regarded as important and even essential in the past have declined in importance, and some of them seem to be on the eve of disappearing altogether. It is not surprising that those who have been trained to regard these as essential to Christianity should think that the Christian religion is declining with them. If, however, these things are not so important as has been supposed, but have gained for a time an exaggerated importance, then their decline to their normal position and the advance of other things to their rightful place, as more important things than has hitherto been supposed—all this is evidence of a healthful advance in Christianity. This question, therefore, will be answered in accordance with the point of view of the one who considers it. If it is to be answered correctly we must put aside all prejudice, and examine the whole situation candidly and with a critical scientific spirit. It is impracticable within the bounds of this article to examine this question on all sides. We can only make a few suggestions relating to it.

It is necessary at the outset to approach the question aright. We must distinguish between what is essential to the Christian religion and what is non-essential. This is not so easy a task as one might imagine. We can only make this distinction generally, and not with scientific precision. In the study of religions we have to distinguish (1) the more fundamental things in the historical institutions and experience in life; (2) the doctrines which express the popular belief or scientific knowledge of the adherents of the religion; and (3) the expression of the religion in ethical principles and moral conduct. The order of development is always life, doctrine, morals. The earlier stages of the Christian religion and of Christian experience at any time and in any community is the vital experience and the institutional organization. Doctrines of faith and knowledge presuppose the vital relation, and morals

presuppose both, and conduct is the final aim and crown of the whole development. And yet there are some scholars who exaggerate the relative importance of each one of the three in its relation to the other two and to the whole.

In our age greater attention is given to Christian ethics and sociology than ever before. A man who has the ethical enthusiasm of our times is inclined to criticise historical Christianity with great severity, because of its failure to realize the highest ethical ideals, and especially those presented by Jesus in his teaching and his example. Historical Christianity is so far below these ideals, even in its best types, that one is inclined to say if the Church has failed so badly in nineteen centuries, what prospect has it in the present or the future? Some good men in our times are disgruntled with historical Christianity for its ethical failures, and keep aloof from the Church on that account; but these are after all proportionately few, and they are unreasonable, for they exaggerate the ethical phase of Christianity over against the doctrinal and the vital; they fail to see what is necessarily involved in the development of the Christian religion, that the ethical age should come last of all; and they also are not just in their estimate of Christian history, for, notwithstanding the failure of the Church, there has been a wonderful and steady ethical advance through the centuries. Indeed, it is Christianity itself which is chiefly responsible for the ethical enthusiasm of the present time, and this is an evidence that Christianity is about to enter upon the last and highest stage of its development. Holy love in principle and practice in the liberty of self-sacrifice is better understood in the Church to-day than ever before, and it is becoming more influential in the Church and in the world. The Church is about to put forth the supreme ethical influence of holy love to transform society and the lives of men.

In large sections of the Church the greatest stress is still laid upon Christian doctrine, especially as expressed in dogmatic forms. If a man thinks that orthodox doctrine is the test of a healthful and vigorous church, he will make that the determining element in his judgment whether Christianity is advancing or declining. In this sphere we have to distinguish three things: (1) The popular orthodoxy, which is determined by the consensus of teaching from the pulpit; (2) the scholarly orthodoxy, which is determined by the teaching of the theologian from the chairs of the theological schools and in text-books of dogmatic theology; (3) the official orthodoxy, which is determined by creeds, liturgies, confessions of faith, and canons of the Church.

There can be no doubt that there has been a great overturning of dogma in our times, and it is altogether probable that this will

assume much greater dimensions. Many think that dogma has had an exaggerated importance in the past, and, from their point of view, the Christian religion has made an advance by pushing dogma back to a less dominant position. Those who maintain that dogma is of supreme importance naturally think that the Christian religion declines when dogma is discredited in the Christian community. There can be little doubt that a large number of men absent themselves from church attendance because they dislike the popular orthodoxy, which seems to them antiquated, unscientific, and untrue. Many refuse to unite with religious organizations which are dominated by an orthodoxy representing the theories of scholastic theology. Many remain apart from the churches because they are unwilling to be responsible in any way for their official orthodoxy. Many, born and trained in Presbyterian families, refuse to remain in an organization which is responsible for the hard doctrines set forth in the Westminster Confession. Many Methodists refuse to be compromised by Wesley's doctrines and Wesley's rules of life. Many refuse to remain Baptists because of what is involved in close communion. Many refuse to be Episcopalians because they resent the doctrines and practices of sacerdotalism. And so we could find, more or less in all religious communions, a dissatisfaction with dogmas—sometimes superficial, giving a plausible excuse for absence, sometimes profound, inciting active hostility to the Church. If all of these dissatisfied ones are to be regarded as hostile or indifferent to Christianity, then it is evident that an army of Christians have practically separated themselves from the Church in our time, and we must say that Christianity has in this respect declined. If, on the other hand, we think that these dissatisfied and disgruntled ones are yet Christians, and that they are maintaining their faith in Christ in opposition to an unreasonable church, that they are exerting an important influence in the transformation of the dogmas of the Church, then we may say that this is an evidence that Christianity is in a state of transition, that it is on the move away from an untenable position of exaggerated dogma to a truer and stronger position, in which dogma will be transformed and given its normal place and importance.

The effort to throw off the bondage of the popular and the scholastic dogma is an advance, and not a decline; it is an advance into the realm of freedom. It first gives the possibility of a critical re-examination of the dogmatic faith of the Church. Only by the application of the scientific methods of our age to dogma is it possible for our age to verify dogma and accept it as valid and reliable. We can not rely on anything that is merely traditional or

the product of the logical analysis of premises which remain themselves unverified. The revolt against the confessional orthodoxy, especially in the Presbyterian, Reformed, and Lutheran Churches, is not a sign of decline, as some think, but a wholesome movement which indicates a determination to know the truth and to hold nothing but the truth.

The Chicago-Lambeth articles, adopted by the whole Anglican communion throughout the world, reduces the essential doctrines of Christ's Church to the Nicene Creed and the Apostles' Creed; those creeds in which all the great historical churches, the Greek and the Oriental, the Roman and the Protestant, agree. This marks a dogmatic advance, not a dogmatic decline, because it makes the distinction between the essential and unessential doctrines, it defines essential doctrines by holding up ancient fundamental historical creeds; it thereby represents all other matters as within the realm of the unessential doctrines, the province of Christian liberty.

The churches are therefore readjusting themselves in their relation to Christian doctrine, and the Christian community is readjusting itself likewise. The offensive features of Christian dogma, while still retained and advocated by some theologians and some communions, have been in great measure removed by other theologians and communions, and the process is going on with great rapidity. The war against science, criticism, literature, and art—all that is characteristic of our age—is gradually being limited to a smaller number of theologians and denominations, and there is ever an increasing number of theologians and churches which fully recognize all the achievements of modern times and who are at work in harmonizing them with the verified Christian dogmas in a larger, grander system—in a new theology representing all that is noblest and best in Christianity as applied to the modern world. While this process is going on, the dissatisfied ones will take some little time to find their new church homes and to adjust themselves to new conditions and circumstances.

So far as the great mass of mankind is concerned, the chief factor in the Christian religion is the fundamental one of the Christian life and the Christian institution, and the advance or decline of Christianity will be judged from this point of view. Here, however, we must recognize that there are several types of religious life which sometimes combine in one community, but which ordinarily exist apart as characteristic of different temperaments, different nations, different races. The lines of cleavage in historical Christianity are for the most part racial, national, or temperamental. We have to take this into account when we consider the

religious life and institutions of different countries. What a difference there is in religion from this point of view in the great centers, such as Rome, St. Petersburg, Berlin, London, Edinburgh, New York! That man would go far astray who should undertake to use any one of these as a test of any or of all the others.

Let us consider, for example, the question of participation in the services of the Church. Rome has apparently, from a Protestant point of view, an abnormal number of churches, and in these churches an extraordinary number of chapels and altars. The reason for this is that there is an immense number of clergy in Rome, and all these altars are needed that they may perform the most important of their duties—the sacrifice of the mass. The churches, chapels, and altars are not erected for the people merely—if so, vastly fewer would be necessary—but for the priests who sacrifice for the people even when they are absent. Berlin has apparently very few churches, and these are not always well attended by the people, and are used infrequently except on Sundays. Judging from this, it would be a very irreligious city; but any one who really knows Berlin would not say that it is less religious than Rome. The religion of the German people finds its expression in a mystic type of personal piety and of family and social life; it maintains and propagates itself without frequent attendance upon public worship.

In London regular attendance upon public worship is commonly regarded as indispensable for the maintenance of the Christian religion. Therefore Christian people frequent the churches to an extent that is unknown on the continent of Europe. But to make the British habit of frequenting the Church for public worship a test of the vitality of the Christian religion in the great cities of the Continent would be altogether unjust and untrue. The historical development of religion in Great Britain has brought about an entirely different state of affairs there from that which we find everywhere else in the world. The situation in Great Britain is therefore special, peculiar, and, one might say, abnormal as compared with the situation in other parts of the world. In the United States the original population was chiefly British, and therefore followed British methods in religion. But in the present century our land, and especially our cities, have filled up with a population from the continent of Europe, bringing with them Continental methods of worship which would not yield to or readily adopt British methods. Intermarriage with the British stock and familiar converse in society have tended to assimilation, and therefore the situation has gradually and inevitably emerged that the Christianity of New York and Chicago and our other great

cities has assumed an intermediate position between that of the Continent and that of Great Britain. The religious customs characteristic of British Christianity have undoubtedly declined—they have yielded to the influence of Continental Christianity. If British Christianity is the norm by which we are to judge, then Christianity has declined in the United States. If, however, it is not the norm, then it might appear that an intermediate position, such as we have attained by the assimilation of the British and the Continental types, may be a real advance and gain, because of the appropriation of some of the best features of both methods and the rubbing off of some of the eccentricities and excrescences of both. A decline in the relative attendance upon the public worship, and especially upon the second service on Sunday, is exactly what we would anticipate under the circumstances. It is altogether probable that the decline is much less than we had the right to expect in view of the vast influence exerted upon us by Continental types of Christianity during the past half century. And it is altogether probable that the decline has not reached its normal goal. Especially is this the case when we take into consideration other influences which tend to diminish the attendance upon public worship.

1. In Great Britain, where the churches were established by law, the state and Church were so entwined that it was a badge of good citizenship to attend upon public worship. In antithesis with this, attendance of the nonconformists upon public worship was regarded as a standing by their principles and a test of fidelity and courage. These influences worked also in the United States during the colonial period; but during the present century this motive has lost its influence, and it is to be feared that politicians as such feel under no special obligation to attend church, especially in view of the attitude of many of the ministry as to political life and political questions.

2. In Great Britain it has been a badge of social propriety to attend public worship. Social influences still prevail greatly in the United States, in villages and small cities, and even to some extent in the churches in the great cities, where they are organized and conducted in social lines as social religious clubs. But this influence is much weaker than it used to be, and it is gradually passing away.

3. The pulpit was once the chief means of instruction and of intellectual and moral stimulation for the people. The preacher was the people's orator. The pulpit has in great measure lost its attractive power in this regard. The daily and weekly press have a greater influence in public instruction. The multiplication of cheap books also takes from the preacher a large share of his

influence in this regard. Oratory in legislative bodies has to a great extent lost its influence. Its place has been taken by simple, compact, time-saving statements, often printed but not delivered. Committees do the work which used to be done after discussion before the public. So the people will not listen now to the pulpit orator of former generations. They demand short, crisp sermons that bristle with points, and are practical and helpful. In other words, the oratorical and highly intellectual character of the pulpit which used to attract worshipers no longer attracts them. They feel that they can get more benefit in this regard by reading in the comfort of the home. Multitudes of people can no longer be induced to attend church to be instructed by the minister or to get his judgment on topics of the time, or to be stirred by his eloquence; they can get all these things cheaper and easier by reading at home. When, now, this is re-enforced by the fact that multitudes dislike the doctrines of the Church, and resent them when they are preached, we can easily understand that church attendance should decline very greatly from this reason.

But this is no evidence that the Christian religion has declined. If men absent themselves from public worship because it is no longer necessary for them, as good citizens and as respectable members of society, to attend, or because they may get their instruction and stimulation elsewhere easier and with less expenditure of time and money, that is simply an evidence that attendance upon church in the past has been due in great measure to other than religious reasons, and that, these no longer holding, attendance has disappeared with them. The attendance upon public worship, though reduced so far as number is concerned, is now more simply and purely for religious reasons, and therefore minister and people may with greater freedom make the services more distinctly religious.

This is indeed the real situation that has emerged. The sermon has declined relatively in importance, and rightly so. It had an exaggerated importance in the Protestant Church, especially in the non-liturgical churches. There is a world-wide tendency now, which is increasing in power, to improve and enlarge the worship of the Church. Liturgies and ceremonies of worship are more discussed now in the Protestant world than are sermons and lectures, because it is becoming every day more evident that the Church is organized for common prayer and for public worship, and not merely to furnish a pulpit for a minister. The pulpit is more and more being merged in the worship, and is losing its domination over the worship. With this tendency goes increased attention to the Holy Sacraments, especially the Holy Communion, more frequent celebrations and more frequent participation, increased

opportunity of worship during Sunday and during the week, and also therewith the greatly increased attention to the organization of the Church for aggressive Christian work. Those who think that the pulpit is everything in the public service naturally suppose that with the decline of the pulpit Christianity declines, but those who think that public worship is the essential thing in the Church rejoice at the changes that are taking place, and hold that Christianity is advancing. They maintain that it is not so important for the Church to gather large crowds to listen to the sermon as it is for the church doors to be ever open, with frequent services for the convenience and help of worshipers at any time, without regard to whether they are few or many, assured that thereby a much greater number of people are reached and benefited than by the former limited methods.

It is sometimes said that biblical criticism has undermined faith in Holy Scripture, and that, therefore, many absent themselves from public worship. But there is no real evidence for it. I doubt not that the opponents of biblical criticism drive many people from their congregations, just as they do when they attack the sure results of modern science, or expose their ignorance in the discussion of political and economical questions in which they have not been trained; but these people simply remove to other congregations where they will not be offended by obscurantism and intolerance. Biblical criticism really makes the Bible more attractive to the people, and its reading and exposition more interesting and influential in the Church.

A careful study of the situation makes it evident that the Christian religion is not declining in our land; but it is passing through a transition state, putting off antiquated dogmas, customs, and methods, and adapting itself to the modern world, and transferring itself so as to better accomplish its work. In no age has Christianity made more advance than in the century now drawing to a close.

The Indians of Bolivia are described by Sir Martin Conway as "an exceedingly bigoted folk, retaining under a mask of Christianity their ancient superstitions, little altered," and are kept in order by priestly management rather than by force. Mr. Conway was seriously interfered with by them in the prosecution of his researches because the nature of his undertaking involved some outrage to their superstitions. They regard the mountains above the level of habitation as part of the other world, and holding, among other fancies, that a golden bull and a golden cross planted by supernatural agency stood on the summit of one of the peaks round the base of Mount Serata, thought that the object of the explorer's expedition could be nothing else than to obtain possession of these priceless treasures. Hence they offered formidable opposition to him.

A CENTURY OF GEOLOGY.*

By Prof. JOSEPH LE CONTE.

GEOLOGY is one of the youngest of the sciences. It may almost be said to have been born of the present century. It is true that knowledge concerning the structure of the earth had been accumulating ever since the time of the Greeks and Romans; it is true that these materials became more abundant and were better organized in the eighteenth century; but this knowledge had not yet taken form as a distinct branch of science until about the end of that century. There are two distinctive marks of scientific as compared with popular knowledge: First, that its fundamental idea is clearly conceived; and, second, that its method is distinctly inductive.

1. Fundamental Idea.—The fundamental idea underlying geological thought is the history of the earth. Now, until the beginning of the present century the earth was not supposed to have any history. It was supposed to have been made at once, out of hand, about six thousand years ago, and to have remained substantially unchanged ever since as the necessary theater of human history. Changes were known to have taken place and in less degree to be still taking place, but these were not supposed to follow any law such as is necessary to constitute a history, and thus to constitute a science distinct from geography. Buffon, about the middle of the last century, did indeed bring out dimly the idea of an abyss of time, preceding the advent of man, in which the earth was inhabited by animals and plants wholly different from those of the present day, but he was compelled by the priests of the Sorbonne to retract these supposed irreligious views. So tardily was the fundamental idea of geology clearly conceived that Comte, the great originator of scientific philosophy, in his classification of the sciences in 1820, denied a place to geology because, according to him, it was not a distinct science at all, but only a field for the application of all the sciences. It is evident that he did not perceive the fundamental idea underlying geology and distinguishing it from geography—viz., a life history of the earth through all time. The claim of geology to a place in a scheme of classification is exactly the same as that of astronomy. As astronomy is a field for the application of mathematics, mechanics, physics, and, recently, chemistry, but is distinguished from them all by its characteristic fundamental idea of illimitable space, so geology is a field for the application of all other lower sciences, but is distinguished

* In this article I have attempted to give only the development of geological thought.

from them all by her characteristic fundamental idea of illimitable time. As all other sciences are terrestrial, but astronomy alone celestial, so all other sciences belong to the present—the "*now*"—but geology alone belongs to the illimitable past. The fundamental idea of the one is infinite *space*, of the other infinite, in sense of inconceivable, *time*. All other sciences, including astronomy, are but a flash-light view of Nature. Geology alone is a view of Nature in continuous movement, a life history—an evolution of Nature. This mode of thought began to dawn only in the closing years of the last and the opening years of the present century. It seems to have been first clearly conceived by the mind of Hutton in the last part of the eighteenth century.

2. Inductive Method Applied.—When the true idea underlying geology was clearly conceived and geology thus distinctly separated from other departments of science, geology may be said to have been born. But it was still in helpless infancy, its growth irregular, and even its continuous life uncertain, because a solid basis of inductive method was not yet laid. That basis was laid mainly by Hutton in 1795,* and still more clearly by Charles Lyell in 1830, in the principle that the study of *causes now in operation* is the only true foundation of geology.

Geological changes, of course, belong to the irrevocable past, and are therefore hopelessly removed from *direct* observation. Their causes and process must be reconstructed by the skillful use of the scientific imagination. Until Lyell, more or less probable hypotheses seemed all that was possible. What a field was here for the conflict of opposite extreme views! But Lyell showed that "causes now in operation" are producing similar effects under our eyes, if we will only observe. From that moment geology became a truly inductive science and its indefinite progress assured.

These two events, then—viz., the conception of geology as a distinct science, and the introduction of a true scientific method—are the greatest epochs in the history of geological science. Some dim adumbrations of these appear before this century, especially the former in the mind of Buffon, and the latter somewhat fully in the mind of Hutton, but they were not generally accepted and had not become working principles until the beginning and even some time after the beginning of the nineteenth century. These must be borne in mind in all we have further to say of the progress of geology through the century.

When the century opened, the war between the Neptunists and the Plutonists, between the Wernerites and the Huttonites, was still going on, but was approaching the usual result in such cases

* Hutton's Theory of the Earth.

of dispute—viz., the recognition of the fact that there was truth on both sides, and they must be combined into a more comprehensive view. The chief difference of opinion still remaining was as to the relative importance of the two agencies, aqueous and igneous. Two great advances took place about the beginning of this century: William Smith, by patient, painstaking field observation and mapping, laid the foundation of stratigraphy; and Cuvier, by his profound and brilliant studies of the wonderful discoveries of extinct mammals in the Eocene basin of Paris, laid the foundations of paleontology. These researches placed in clearer light than ever before the existence of other time-worlds before the present one. William Smith published his tabular view of the British Strata in 1790, but his map was not completed and published until 1815. Cuvier's great work on the Organic Remains of the Paris Basin was published in 1808.

Thus, early in the century the two bases of our science were laid by Smith and Cuvier. We now proceed to touch lightly only the main steps of subsequent growth through the century.

As, in the previous century and the early part of this, the discussion was between the opposite schools of Neptunists and Plutonists, with the final result of reconciliation in a more scientific view which combined these two surface views into a stereoscopic reality, so now the discussions began between catastrophism and uniformitarianism, and ended with a similar final result. Geologists, in the early part of the century, before the study of causes and processes now in operation was generally acknowledged as the only rational basis of a true scientific geology, seeing the frequent unconformities in the geological series and the apparently sudden changes of life forms associated with these unconformities, were naturally led to the conclusion that the whole history of the earth consisted of a series of sudden and violent catastrophes by which the bed of the ocean was suddenly raised and its waters precipitated on the land as a great wave of translation, carrying universal ruin and extermination of all life in its course. Such catastrophes were supposed to be followed by periods of quiet, during which the new earth was repeopled, by direct act of creation, with new forms of life adapted to the new conditions.

This view was in perfect accord with the then accepted doctrine of the supernatural origin and the permanence of species. Species were supposed to have been created at once, out of hand, without natural process, in some place (center of specific origin), spread in all directions as far as physical conditions would allow, but remained unchanged and unchangeable as long as they continued to live or until another universal exterminating catastrophe. Species

are "medals of creation." They are successive individuals struck from the same die, until the die is worn out or broken. Then a new die is made, and the process of coinage of identical individuals is renewed.

Thus the whole history of the earth was supposed to consist of a succession of alternate supernatural and natural events. The catastrophes were supernatural; the times of quiet were natural. The creation of new dies or creation of first individuals was supernatural; the coinage of individuals of successive generations was natural. But on the whole the successive conditions of physical geography and the successive faunas and floras were higher and more complex according to a preordained plan. The great apostles of catastrophism were Cuvier in France and Buckland in England. According to Buckland, the last of these great catastrophes was the Quaternary or drift period, and this period was, by him and by many others since, associated with the Noachian Deluge.

Lyell opposed this view with all his power. According to him we can not judge of geological causes and processes except by study of causes and processes now in operation and producing effects under our eyes. The slow operation of similar causes and processes is sufficient—given time enough—to account for all the phenomena in geological history. Thus arose the extreme opposite doctrine of *uniformitarianism*. Things have gone on from the beginning and throughout all time much as they are going on now. This view, of course, required illimitable time, and was of great service in enforcing this idea. But, in revulsion from the previous idea of catastrophism, it undoubtedly was pushed much too far.

Meanwhile the theory of evolution was incubating in the mind of Darwin. Even Lyell, while he established the doctrine of slow uniform changes so far as inorganic Nature was concerned, was still compelled to admit supernatural catastrophic changes in organic Nature. Species, even for Lyell, were still immutable—still there were supernatural creation of first individuals, and continuance of similar individuals by natural process of generation. On the publication of Darwin's Origin of Species by Descent with Modification, Lyell at once embraced the new view as a completion of his principle of causes now in operation and his doctrine of uniformitarianism. In a certain superficial sense evolution is certainly confirmatory of the doctrine of uniformity of causes and processes in the past and the present, but in a deeper sense it is quite contrary in its spirit. Uniformitarians of the Lyell school look upon geology as a chronicle of events—evolutionists as a life history of the earth. The one regards the slow changes as irregular, uncertain, without progress or purpose or goal; the other as an evolution to

higher and higher conditions, as a gradual movement onward toward the present condition and toward man as its goal. The recognition of this is only now approaching clearness. If geology is the history of the evolution of the earth from primal chaos until now, then the conditions have changed at every step, and absolute uniformity is impossible. Extreme uniformitarianism is therefore untenable. Catastrophism and uniformitarianism are opposite extremes which must be combined and reconciled. This reconciliation is only now being completed, and we therefore put off its discussion for the present. Suffice it to say now that geologic thought in this regard has passed through three stages—catastrophism, uniformitarianism, and evolutionism. And this latter is the final stage, because (1) it is a complete reconciliation between the other two, and (2) because it is plastic and indefinitely modifiable and progressive, while the other two are equally rigid and unchangeable by their mutual antagonism.

With these fundamental principles in mind, we proceed to touch briefly the most important advances during the century.

EVOLUTION OF EARTH FORMS.

The idea of the progressive development of the earth in its greater features throughout all geologic time by the action of forces resident in the earth itself preceded the acceptance of the evolution of organic forms. We have said that the fundamental idea of geology is that of the evolution of the earth through all time. Now, it was Dana who first studied geology wholly from this point of view. For him geology was the development of the earth as a unit. Before him, doubtless, geology was a kind of history—i. e., a chronicle of thrilling events—but Dana first made it a philosophic history. Before Dana, geology was an account of the succession of formations and their fossil contents. Dana made it an account of the evolution of earth forms and the concomitant and resulting evolution of organic forms. It is true that first and for a long time his evolutional conception was incomplete. It is true that while he attributed the evolution of earth forms to natural causes and processes, he still shrank from applying similar causes to the changes in life forms, but this was the almost necessary result of the then universal belief in the supernatural origin and the unchangeableness of organic forms. He lived to make his conception of evolution as a natural process, both of the earth and of organic forms, complete.

Ocean Basins and Continents.—If we divide geological causes and processes into two general kinds as to their origin—viz., internal, or earth-derived, and external, or sun-derived—evidently

the former is the original and fundamental kind. These determine earth forms, while the other only modify them; these determine the great features, the other only the lesser features; the former rough-hews the earth features, the latter shapes them. It is the effects of these interior earth forces which are the most important to study. And among these effects the most fundamentally important of all is the formation of those greatest features—the ocean basins and continental arches. The most probable view is that they are formed by unequal radial contraction in the secular cooling of the earth. The earth was certainly at one time an incandescently hot mass, which gradually cooled and contracted to its present temperature and size. Now, if it were perfectly homogeneous both in density and in conductivity in all parts, then, cooling and contracting equally in every part, it would retain its symmetric oblate-spheroid form, though diminishing in size. But if there were any, the least, heterogeneity either in density or especially in conductivity over large areas, then the more conductive areas, contracting more rapidly toward the center radially, would form hollows or basins, and the less conductive areas would stand out as higher arches. Thus were formed the oceanic basin and the continental arches of the lithosphere. The same causes which produced would continue to increase them, and thus the ocean basins would increase in depth and the continents in height.

The hydrosphere is still to be added. In the beginning of this process doubtless the lithosphere was hot enough to maintain all the water in the form of vapor in the atmosphere. But when the surface was cool enough the water would precipitate and partly or wholly cover the earth—whether partly or wholly would depend on the amount of precipitated water and the amount of inequality which had already taken place. The amount of water, as we know, is sufficient, if the inequalities were removed, to cover the whole surface two and a half miles deep. Inasmuch as the forming of the inequalities is progressive and still going on, it seems improbable that the inequalities had become sufficiently great, at the time of precipitation, to hold the waters. If this be so, then the primeval ocean was universal and the future continents existed only as continental banks in the universal ocean.

However this may have been, there seems little doubt that the same cause which produced the inequalities continued to operate to increase them. The ocean basins, so far as these causes are concerned, must have become deeper and deeper, and the continents larger and larger. In spite of many oscillations producing changes mostly on the margins, but sometimes extending over wide areas in the interior of the continent, this, on the whole, seems to be in

accordance with the known geological history of the earth. If so, then *the oceanic basins have always been oceanic basins, and the places of the continents have always been substantially the same.* This introduces a subject on which there has been much discussion recently—viz.:

The Permanency of Ocean Basins.—Closely associated with the Lyellian uniformitarianism was the doctrine of extreme instability of earth features, especially the forms and places of sea and land. Crust movements were irregularly oscillating to such a degree that in the course of geologic history sea and land frequently and completely changed places. Abundant evidence of this was supposed to be found in the unconformities so frequent in the stratified series. The tendency of that time was toward a belief in up-and-down movements, back-and-forth changes, without discoverable law, rather than progressive onward movement. On first thought it might seem that such lawless movement was rather in keeping with catastrophism than uniformitarianism. But not so, for the movements are supposed to be very slow. Again, it might seem on first thought that gradual progressive change—in a word, evolution—would be peculiarly in accord with uniformitarian ideas. But again not so, because this doctrine was, above all, a revulsion from the idea of supernatural purpose or design or goal contained in catastrophism. Uniformitarianism strongly inclined toward purposelessness, because of its supposed identity with naturalism. Thus for a long time, and still with many geologists, the tendency is toward a belief in irregular movements without discoverable law, toward instability of even the greatest features of the earth—viz., sea basins and continental arches. Geology for them is a chronicle, not a life history.

The contrary movement of thought may be said to have commenced with Dana. Dana studied the earth as a unit, as in some sense an organism developing by forces within itself. The history of the earth is a life history moving progressively toward its completion. The forces originating oceanic basins and continental arches still continue to deepen the former and enlarge the latter. From this point of view, oceanic basins and continental arches must have always been substantially in the same places. Oscillations there have been at all times and in all places, but they affect mainly the outlines of these great features, though sometimes affecting also the interior of continents and mid-sea bottoms, but not sufficiently to change greatly their general form, much less to interchange their places.

Such is the doctrine of permanency of oceanic basins. It is undoubtedly a true doctrine, but must not be held in the rigid

form characteristic of early thought. The forces originating oceanic basins still continue to deepen them and to increase the size and height of continents, but other forces are at work, some antagonizing (i. e., cutting down the continents and filling up the ocean beds), and still others determined by causes we little understand, by oscillations over wide areas, greatly modifying and often obscuring the effects of the basin-making movements. Here, then, we have two kinds of crust movements: the one fundamental and original, determining the greatest features of the earth and moving steadily onward in the same direction, ever increasing the features which it originates; the other apparently lawless, uncertain, oscillating over very wide areas, modifying and often obscuring the effects of the former. The old uniformitarians saw only the effects of the latter, because these are most conspicuous; the new evolutionists add also the former and show its more fundamental character, and thus introduce law and order into the previous chaos. The former is the one movement which runs ever *in the same direction through all geologic time.* The latter are the most common and conspicuous now and in all previous geologic time. The former underlies and conditions and unifies the history; the latter has practically determined all the details of the drama enacted here on the surface of the earth. Of the causes of the former we know something, though yet imperfectly. Of the causes of the latter we yet know absolutely nothing. We have not even begun to speculate profitably on the subject, and hence the apparent lawlessness of the phenomena. A fruitful theory of these must be left to the coming century.

Mountain Ranges.—If oceanic basins and continental domes constitute the greatest features of the earth's face, and are determined by the most fundamental movements of the crust, surely next in importance come great mountain ranges. These are the glory of our earth, the culminating points of scenic beauty and grandeur. But they are so only because they are also the culminating points, the theaters of greatest activity, of all geological forces, both igneous and aqueous—igneous in their formation, and aqueous both in the preparatory sedimentation and in the final erosive sculpturing into forms of beauty. A theory of mountain ranges therefore lies at the bases of all theoretical geology. To the pre-geologic mind mountains are the type of permanence and stability. We still speak metaphorically of the *everlasting* hills. But the first lesson taught by geology is that nothing is permanent; everything is subject to continuous change by a process of evolution. Mountains are no exception. We know them in embryo in the womb of the ocean. We know the date of their

birth; we trace their growth, their maturity, their decay, their death; we even find in the folded structure of the rock, as it were, the fossil bones of extinct mountains. In a word, we are able now to trace the whole life history of mountains.

Mountains, therefore, have always been a subject of deepest interest both to the popular and the scientific mind—an interest intensified by the splendors of mountain scenery and the perils of mountain exploration. The study of mountains is therefore coeval with the study of geology. As early as the beginning of the present century Constant Prevost observed that most characteristic structure of mountains—viz., their folded strata—and inferred their formation by lateral pressure. All subsequent writers have assumed lateral pressure as somehow concerned in the formation of mountains. But that the whole height of mountains is due wholly to this cause was not generally admitted or even imagined until recently. It was universally supposed that mountains were lifted by volcanic forces from beneath, that the lifted strata broke along the top of the arch, and melted matter was forced through between the parted strata, pushing them back and folding them on each side. And hence the typical form of mountain ranges is that of a granite axis along the crest and folded strata on each flank. But attention has lately been drawn to the fact that some mountains, as, for example, the Appalachian, the Uintah, etc., consist of folded strata alone, without any granite axis. In such ranges it is plain that the whole height is due not to any force acting from below, but to a lateral pressure crushing and folding the strata, and a corresponding thickening and bulging of the same along the line of crushing. Then the idea was applied to *all* mountain ranges. So soon as the prodigious amount of erosion suffered by mountains, greater often than all that is left of them, was fully appreciated, it became evident that the granite axis so characteristic of mountains was not necessarily pushed up from beneath and protruded through the parted strata, but was in many cases only a sub-mountain core of igneous matter slowly cooled into granite and exposed by subsequent erosion greatest along the crest.

Next, attention was drawn to the enormous thickness of the strata involved in the folded structure of mountains. From this it became evident that the places of mountains before they were formed were marginal sea bottoms off the coasts of continents, and receiving the whole washings of the continents. Thus the steps of the process of mountain formation were (1) accumulation of sediments on offshore sea bottoms until by *pari passu* subsidence an enormous thickness was attained. This is the *preparation.* (2) A yielding along these lines to the increasing lateral

pressure with folding and bulging of the strata along the line of yielding, until the mountain emerges above the ocean and is added to the land as a coast range. This is mountain *birth.* (3) As soon as it appears above the water it is attacked by erosive agents. At first the rising by continuance of the crushing and bulging is in excess of the erosion, and the mountain grows. This is mountain *youth.* (4) Then supply and waste balance one another, and we have mountain *maturity.* (5) Then the erosive waste exceeds the growth by up-bulging, and mountain *decay* begins. (6) Finally, the erosive forces triumph and the mountain is clean swept away, leaving only the complexly folded rocks of enormous thickness to mark the place of a former mountain. This is mountain *death.* Such briefly is the life history of a mountain range.

In all this we have said nothing about causes. In this connection there are two points of especial importance: (1) Why does the yielding to lateral pressure take place along lines of thick sediments? (2) What is the cause of the lateral pressure?

1. *Cause of Yielding to Lateral Pressure along Lines of Thick Sediments.*—The earth was once very hot. It is still very hot within, and still very slowly cooling. If sediments accumulate upon a sea bottom the interior heat will tend to rise so as to keep at the same distance from the surface. If the sediments are very thick, say five to ten miles, their lower parts will be invaded by a temperature of not less than 500° to 1,000° F. This temperature, in the presence of water (the included water of the sediments), would be sufficient to produce softening or even fusion of the sediments and of the sea floor on which they rest. This would establish a line of weakness, and therefore a line of yielding, crushing, folding, bulging, and thus a mountain range. In the first formation of a range, therefore, there would necessarily be a submountain mass of fused or semifused matter which by the lateral crushing might be squeezed into cracks or fissures, forming dikes. But in any case the sub-mountain mass would cool into a granite core which by erosion may be exposed along the crest. The explanation seems to be satisfactory.

2. *Cause of the Lateral Pressure.*—No question in geology has been more discussed than this, and yet none is more difficult and the solution of which is more uncertain. But the most obvious and as yet the most probable view is that it is the result of the secular contraction of the earth which has gone on throughout its whole history, and is still going on.

It is admitted by all that in an earth cooling from primal incandescence there must come a time when the surface, having become substantially cool and receiving heat also from the sun, would no

longer cool or contract, but, the interior being still incandescently hot, would continue to cool and contract. The interior, therefore, cooling and contracting faster than the exterior crust, the latter following down the ever-shrinking nucleus, would be thrust upon itself by a lateral or tangential pressure which would be simply irresistible. If the earth crust were a hundred times more rigid than it is, it still must yield to the enormous pressure. It does yield along its weakest lines with crushing, folding, bulging, and the formation of mountain ranges.

This is the barest outline of the so-called "contractional theory of mountain formation." Very many objections have been brought against it, some of them answerable and completely answered, but the complete answer to others must be left to the next century. Perhaps the greatest objection of all is the apparent insufficiency of the cause to produce the enormous amount of folding found not only in existing mountains but in the folded structure of rocks where mountains no longer exist. But it will be observed that I have thus far spoken only of contraction by loss of heat. Now, not only has this cause been greatly underestimated by objectors, but, as shown by Davison and especially by Van Hise, there are many other and even greater causes of contraction. It would be out of place to follow the discussion here. The subject is very complex, and not yet completely settled.

We have given the barest outline of the history of mountain ranges and of the theory of their formation as worked out in the last third of the present century, and, I might add, chiefly by American geologists. So true is this, that by some it has been called the "American theory."

Oscillatory Movements of the Earth's Crust over Wide Areas.—We have already spoken of these as modifying the effect of the ocean-basin-making movements, and therefore now touch them very lightly. These differ from the movements producing oceanic basins on the one hand and mountain ranges on the other, by the fact that they are not continuously progressive in one direction, but *oscillatory*—now up, now down, in the same place. Again, they do not involve contraction of the whole earth, but probably are always more or less local and compensatory—i. e., rising in one place is compensated by down-sinking in some other place. Nevertheless, they often affect very wide areas—sometimes, indeed, of more than continental extent—as, for example, in the crust movements of the Quaternary period or ice age.

These are by far the most frequent and most conspicuous of all crust movements—not only now, but also in all geological times. If ocean-basin-forming movements are the underlying cause and

condition of the evolution of the earth, these wide oscillations, by increasing and decreasing the size and height of continents and changing greatly their contours, have determined all the details of the drama enacted on the surface, and were the determining cause of the varying rates and directions of the evolution of the organic kingdom. These were the cause of the unconformities and the corresponding apparent wholesale changes in species so common in the rocky strata, and which gave rise to the doctrine of catastrophism of the early geologists. These also have so greatly modified the contours of the continents and their size by temporary increase or decrease that they have obscured the general law of the steady development of these, and therefore their substantial permanency.

Although the most important of all crust movements in determining the whole history of the earth, and especially of the organic kingdom, we shall dwell no further on them, because no progress has yet been made in their explanation. This, too, must be left to the workers of the twentieth century.

The Principle of Isostasy.—The principle of static equilibrium as applied to earth forms was first brought forward (as so many other valuable suggestions and anticipations in many departments of science) by the wonderfully fertile mind of Sir John Herschel, and used by him in the explanation of the sinking of river deltas under the increasing weight of accumulating sediments.* It was afterward applied to continental masses by Archbishop Pratt † and by the Royal Astronomer Professor Airy.‡ But for its wide application as a principle in geology, its clear definition, and its embodiment in an appropriate name, we are indebted to Major Dutton, United States Army.#

The principle may be briefly stated as follows: A globe so large as the earth, under the influence of its own gravity, must behave like a very stiffly viscous body—that is, the general form of the earth and its greatest inequalities must be in substantial static equilibrium. For example, the general form of the earth is oblate spheroid, because that is the only form of equilibrium of a rotating body. Rotation determines a distribution of gravity with latitude which brings about this form. With any other form the earth would be in a state of strain to which it must slowly yield, and finally relieve itself by becoming oblate. If the rotation stopped, the earth would accommodate itself to the new distribution of gravity and become spherical.

* Philosophical Magazine, vol. ii, p. 212, 1837; Quarterly Journal of Geological Society, vol. ii, p. 548, 1837.

† Philosophical Magazine, vol. ix, p. 231, and vol. x, p. 240, 1855.

‡ Philosophical Trans., 1855, p. 101.

Philosophical Society of Washington, 1892.

The same is true of the large inequalities of surface. Oceanic basins and continental arches must be in static equilibrium or they could not sustain themselves. In order to be in equilibrium the sub-oceanic material must be as much more dense than the continental and sub-continental material as the ocean bottoms are lower than the continental surfaces. Such static equilibrium, by difference of density, is completely explained by the mode of formation of oceanic basins already given.

So also plateaus and great mountain ranges are at least partly sustained by gravitative equilibrium, but partly also by earth rigidity. It is only the smaller inequalities, such as ridges, peaks, valleys, etc., that are sustained by earth rigidity alone.

These conclusions are not reached by physical reasonings alone, but are also confirmed by experimental investigations. For example, a plumb line on the plains of India is deflected indeed toward the Himalayas, as it ought to be, but much less than it would be if the mountain and sub-mountain mass were not less dense and the sub-oceanic material more dense than the average.* Again, gravitative determinations by pendulum oscillations, undertaken by the United States along a line from the Atlantic shore to Salt Lake City, show that the largest inequalities, such as the Appalachian bulge, the Mississippi-basin hollow, and the Rocky Mountain bulge, are in gravitative equilibrium—i. e., the mountain and sub-mountain material is as much lighter as the mountain region is higher than the Mississippi-basin region.

Now, so sensitive is the earth to changes of gravity that, given time enough, it responds to increase or decrease of pressure over large areas by corresponding subsidence or elevation. Hence, all places where great accumulations of sediment are going on are sinking under the increased weight, and, contrarily, all places where excessive erosion is going on, as, for example, on high plateaus and great mountain ranges, are rising by relief of pressure.

This principle of isostasy is undoubtedly a valuable one, which must be borne in mind in all our reasonings on crust movements, although its importance has been exaggerated by some enthusiastic supporters. Its greatest importance is not as a cause *initiating* crust movements or determining the features of the earth, but rather as conditioning and modifying the results produced by other causes. The idea belongs wholly to the latter half of the present century. Commencing about 1840, it has grown in clearness and importance to the present time.

[*To be concluded.*]

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* Pratt, Philosophical Magazine, vol. ix, p. 231, 1855; vol. x, p. 340, 1855; vol. xvi, p. 401, 1858.

THE APPLICATIONS OF EXPLOSIVES.

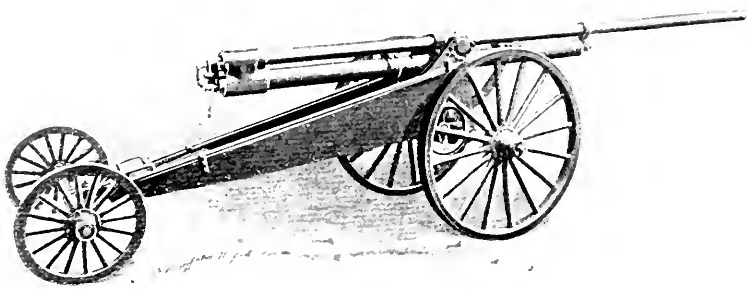
By CHARLES E. MUNROE,
PROFESSOR OF CHEMISTRY, COLUMBIAN UNIVERSITY.

[*Concluded.*]

IT is apparent that the range of even the most highly perfected torpedo is comparatively short, while their accuracy of travel is low. Besides, their propelling, controlling, and discharging mechanisms are complicated, delicate, and easily deranged, they are very expensive, and not only the explosive chamber but the entire system is destroyed in use. The superiority of gunpowder guns as a means of throwing projectiles to great distances with accuracy is well known, and their capacity for safely and efficiently projecting shells filled with gunpowder has long been demonstrated. It was obvious that as the superior destructive power of dynamite, gun cotton, and other high explosives became known and their commercial manufacture was assured, attempts would be made to employ them as bursting charges for shells. Experiments to demonstrate how this might be done and what effects could be expected were begun more than forty years ago, and have been continued in many different places from time to time ever since; but while it has proved that small charges might be fired with low velocities and pressures in ordinary shell, and large charges in specially constructed shell or in specially prepared forms of charge, with comparative safety so far as the premature explosion of the explosive charge itself is concerned, yet these bodies are so sensitive to the shock resulting from the discharge of the propellant, the heat generated by its combustion, and that arising from friction in the "set back" of the shell charge and the rotation imparted by the rifling, that they can not be safely fired from modern high-power guns under service conditions, particularly as these explosives all require that the shell shall be fitted with a detonator in order that the charge may be fully exploded. The most promising results with explosives of this class have been obtained with compressed wet gun cotton, which has been packed directly in the shell in rigid blocks completely filling the shell cavity, or cut in cubes and

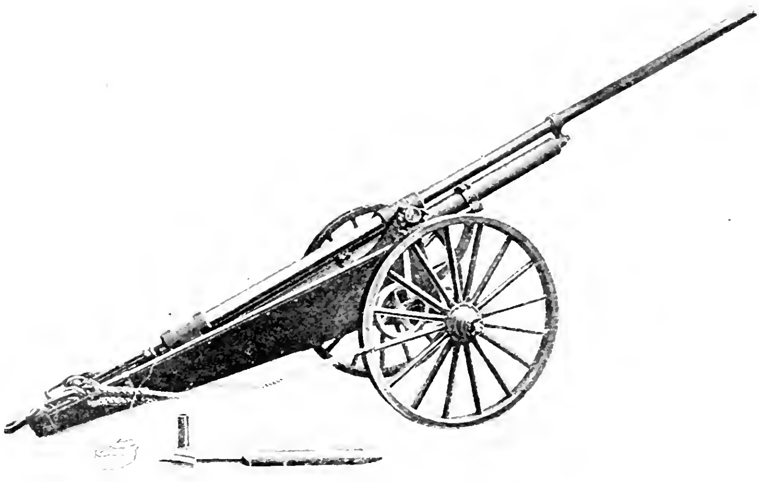
GUN-COTTON SHELL AFTER IMPACT.

cemented in the cavity with carnauba wax, for shell filled in the former manner, but unfused, were repeatedly fired, in 1887 and 1888, at Newport, R. I., from 24-pounder Dahlgren howitzers and



SIMS-DUDLEY PNEUMATIC GUN, LIMBERED UP.
(Courtesy of the Scientific American.)

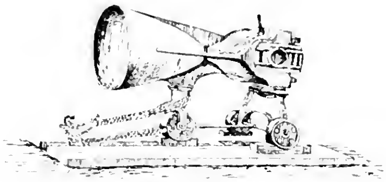
20-pounder muzzle-loading rifles with service charges of powder, and though they were fired point blank into the masonry escarpment of the old fort on Rose Island, but fifty yards distant from the muzzle, so that the shells were broken up or distorted and the gun cotton in them subjected to a powerful compression, yet not only was there no premature explosion, but none of the shell



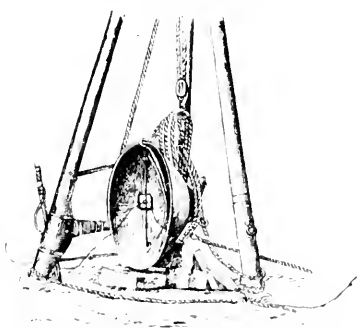
SIMS-DUDLEY PNEUMATIC GUN, IN BATTERY.
(Courtesy of the Scientific American.)

exploded by impact. About the same time fused shell containing cemented gun cotton were fired in Germany, with an initial velocity of fourteen hundred feet per second, and they passed com-

pletely through four inches and three quarters of compound armor, backed with twenty-four inches of oak, and burst inside the bomb-proof, while in 1897 fused armor-piercing shells containing wet gun cotton were fired from the six-inch quick-firing gun, with a muzzle velocity of nearly nineteen hundred feet per second, which completely perforated three inches of steel and burst behind the plate. Encouraged by these results, this system was adopted by our army officials, but, on trial in larger calibers at Sandy Hook, it gave rise to premature explosions, and the tale of disaster reached its climax on April 29, 1899, when Captain Stuart, of the Ordnance Corps, was superintending the loading of a twelve-inch torpedo shell with wet gun cotton by compressing it into the shell, for an explosion resulted which killed four men instantly and fatally wounded two others, Captain Stuart being one of them.

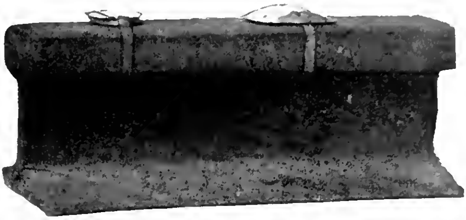

Tyndall's Bronze Bell-mouthed Gun.

The history of the attempts made to use nitroglycerin, dynamite, explosive gelatin, and explosives of this class as bursting charges for shell fired from service guns is even less satisfactory than that given for gun cotton. It is not surprising, therefore, that inventors should have proposed catapults, slings, rotary wheels, and other means for projecting these powerful agents into the enemy's midst, but the Mefford air gun, as mounted on the United States steamship Vesuvius, and the Sims-Dudley gun, in which a reduced charge of powder is fired in a chamber exterior to the gun proper, were deemed to possess sufficient merit to warrant their trial in the field. These devices were employed in the recent war with Spain, the pneumatic guns on the Vesuvius being used to throw shells containing three hundred pounds of gun cotton, while the Sims-Dudley guns were used on land to throw small charges of dynamite or explosive gelatin; but, beyond frightening the enemy by the startling character of their reports, these superficial charges produced no serious effect.

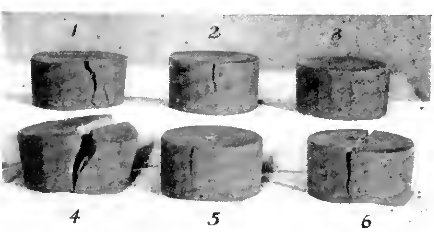

Mirror or Reflector in which to fire Gun Cotton.

There is a widespread misapprehension in regard to the devastating effect of these high explosives, for when unconfined the effect even of large charges of them upon structures is comparatively

slight. At the Naval Ordnance Proving Ground, so long ago as 1884, repeated charges of dynamite, varying from five pounds to one hundred pounds in weight, were detonated on the face of a vertical target consisting of eleven one-inch wrought-iron plates bolted to a twenty-inch oak backing, until 440 pounds of dynamite had been so detonated in contact with it, and yet the target remained practically uninjured; while at Braamfontein the accidental explosion of fifty-five tons of blasting gelatin, which was stored in railway vans, excavated but 30,000 tons of soft earth. This last may seem a terrible effect, but the amount of explosive involved was enormous and the material one of the most energetic that we possess, while if we compare it with the action of explosives when confined its effect becomes quite moderate. Thus at Fort Lee, on the Hudson, but two tons of dynamite placed in a chamber in the rock and tamped brought down 100,000 tons of the rock; at Lamberis, Wales, two tons and a half of gelatin dynamite similarly placed threw out 180,000 tons of rock; and at the Talcen Mawr, in Wales, seven tons of gunpowder, placed in two chambers in the rock, dislodged from 125,000 to 200,000 tons of rock. We might cite many such examples, but on comparing these we find that the gunpowder confined in the interior at the Talcen Mawr was over forty-two times as efficient as the explosive gelatin on the surface at Braamfontein, while the dynamite at Fort Lee was over ninety times as destructive.



Railroad Torpedoes fastened on Rail.



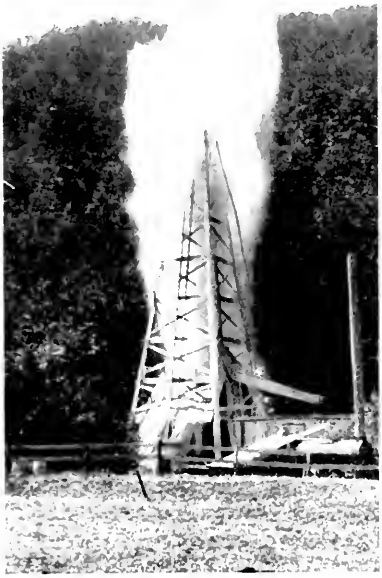
Steel Disks upon which Gun Cotton has been detonated to test their Resistance to Shock. Midvale steel disks after second fire.

Considerations similar to these led me, in 1885,* to point out that high explosives for use in shells must be strongly confined, and in the attack on armored ships they should be fired in projectiles that can "either penetrate the armor partially and explode in place or pierce it completely and burst inside the ship" to secure the greatest efficiency. This requires that the projectiles shall be fired at higher velocities than can be imparted to them by guns of the kind just described, and

* Van Nostrand's Engineering Magazine, vol. xxxii, pp. 1–9, 1885.

which can only be realized at present in modern breech-loading rifles. Although experience has shown the futility of all our efforts to use gun cotton and nitroglycerin explosives in this manner, it has been proved that the nitro-substitution explosives can be employed with safety and effect.

The nitro-substitution explosives are made from nitrobenzenes, nitrotoluenes, nitronaphthalenes, nitrophenols, and bodies of a similar character, and one of them, called joveite, has given excellent results in this country. After having demonstrated that the destructive effect of joveite was greater than that of gunpowder, smokeless powder, or gun cotton, and, by repeated trials under severe conditions, that service shell loaded with it could be fired from service guns under service conditions with safety, on November 3, 1897, the naval officials at Indian Head fired a fused ten-inch Carpenter armor-piercing projectile containing 8.25 pounds of joveite, with a velocity of 1,960 foot-seconds, at a Harveyized nickel-steel plate taken from the armor for the United States steamship Kentucky. The shell passed completely through the armor plate, where it was 14.5 inches in thickness, and burst immediately behind the plate. In a second round an unfused ten-inch Midvale semi-armor-piercing shell containing twenty-eight pounds of joveite was fired with a velocity of 1,925 foot-seconds at the same plate where it was sixteen inches thick. The shell penetrated to a depth of twelve inches, and the heat produced by the upsetting of the shell was so great as to explode the joveite, which broke the plate and burst the shell with tremendous violence. In fact, the explosion was so very severe that the heavy base plug of the shell was sheared longitudinally, an effect never observed before with any explosive fired at the proving ground.



Shooting an Oil Well with Nitroglycerin.

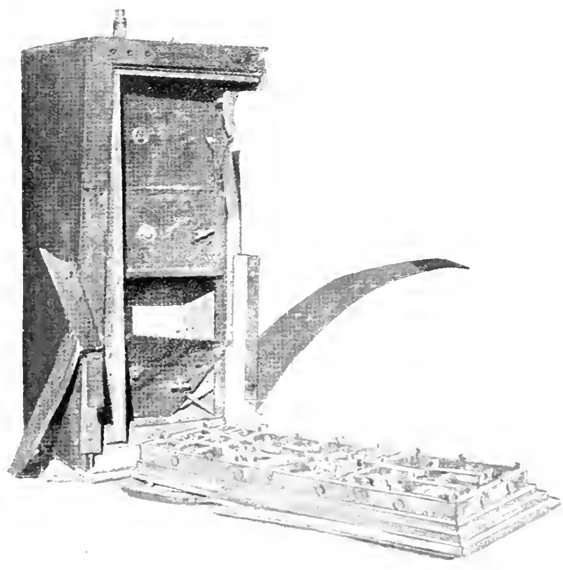
Notwithstanding that no accident occurred in any of the many firings, that the stability and safety of the explosive are assured, and that the explosion has been effected with a well-known and

SAFE TO BE OPENED BY DETONATION OF NITROGLYCERIN. Before the charge was fired.

long-used form of fuse, no provision has yet been made to supply the service with charges for its costly armor-piercing projectiles.

Happily, the force resident in explosives may be applied to the saving as well as to the destruction of human life, advantage having long since been taken of the penetrating power of the report from the discharge of a gun to employ them as signals of distress at sea or as warnings in foggy weather. The English Lighthouse Board, under Professor Tyndall's guidance, some years ago sought to find the form of gun best suited to this purpose, and their experiments led them at first to a bronze gun with a bell-shaped mouth. Subsequently, their attention being called to the sharpness and carrying power of the report from detonating gun cotton, an apparatus was devised in which the gun cotton was detonated in the focus of a parabolic mirror. The best results, however, were attained with rockets carrying gun-cotton charges arranged to be exploded in mid air.

Guns have also been arranged for projecting life-lines between stranded ships and the adjacent shore, and are now employed on a smaller scale for conveying lines to the upper stories of our monumental buildings when they are on fire. By means of guns or rockets, projectiles filled with oil may be cast

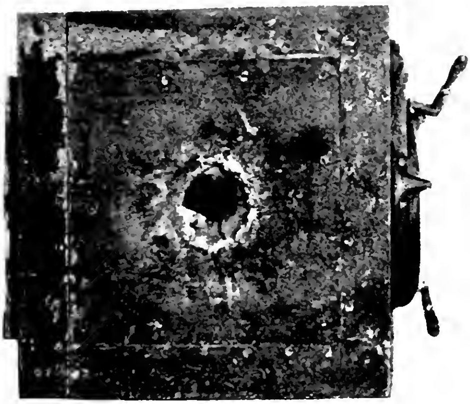


AFTER FIRING CHARGE.

to considerable distances from a vessel in a raging sea, so that the oil, as it diffuses, may still the waters in her course; while sounding-lines may be thrown far in advance of a vessel while she is still under way, and the soundings taken without her laying-to.

Inclosed in shallow tin boxes, which are fixed by lead strips to the top of the rail, explosives are used as torpedoes in the railroad service to give warning, by the report of their explosion as an engine runs over them, that another train is on the same track and but a short distance ahead, and by this means collisions in fogs or on curves are frequently prevented.

Explosives find applications in many industries. The farmer uses them in breaking bowlders, grubbing stumps and felling trees, in shaking the soil to fit it for deep-soil cultivation, and, in the wine-growing districts, to free it from phylloxera, while the farmer's friend has tried by this means, in times of drought, to shake the nerves of Jove and to divert the hailstorm from its course.



Safe perforated by Hollow Dynamite Cartridge.

The iron founder uses them in breaking up large castings. The iron smelter employs them to clear out obstructions in blast furnaces while the latter are still in operation, the dynamite, protected by a clay envelope, being inserted in the red-hot mass which clogs the furnace. The author has proposed to use the detonating explosives for testing the integrity of large masses of metals and their resistance to shock.

Dynamite has been employed in fishing, since submarine explosions of it will kill or stun fish for a long distance about the charge. This method of fishing, which threatened to deplete the waters, has very properly been prohibited by law, but guns are employed for projecting harpoons in the whale fishery, and have reduced very much the danger attending this extra-hazardous occupation.

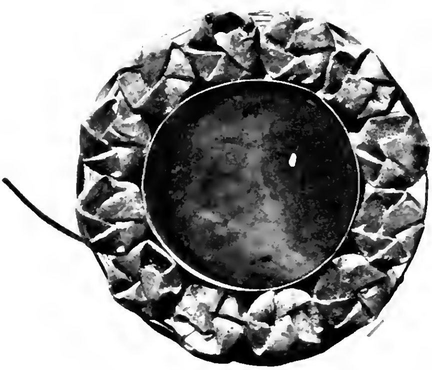
Nitroglycerin, inclosed in tin cans three to five inches in diameter and five to twenty-five feet in length, is used for shooting oil wells to free them from the solid paraffins with which they become choked, or to shake the oil-bearing sandstone so as to produce a greater yield. In this work the loaded can, having a detonating cap attached to its top, is lowered by a wire to the bottom of the well,

which is often fifteen hundred feet or more in depth. A perforated weight is then strung on the wire, and when the torpedo is in place the weight is allowed to fall, strike the cap, and explode the charge.

Hollow Dynamite Cartridge; Elevation.

Dynamite has been used to knock out the blocking from the ways when launching ships. Fired on an iron plate placed on the top of a pile and covered with a tamping of earth or clay, it has successfully and economically replaced the pile driver. It has been found efficient in excavating holes in which to plant telegraph and telephone poles; in driving water out of quicksands in which foundations are to be laid or shafts to be driven; in slaughtering cattle; in breaking down ice dams to prevent inundations; in blowing up buildings to prevent the spread of conflagrations; in razing unsafe walls of burned buildings; in destroying wrecks which endanger navigation, and even in freeing vessels which are hard aground on shoals.

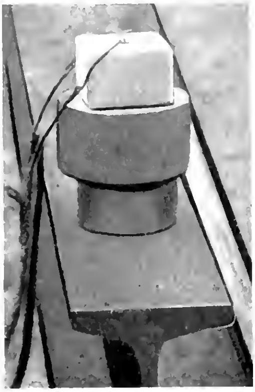
An especially notable instance was in the blasting out of the *débris* in the river at Johnstown after the frightful flood that occurred there, which formed an enormous dam above the bridge and threatened its existence, and which was successfully and expeditiously removed by blasting after all other means had been tried in vain.



Hollow Dynamite Cartridge.
View from below.

In fact, the amount of explosives consumed in the industries is so great that the quantity employed for military purposes sinks into insignificance. Yet we have failed to refer to those industries—quarrying and mining, and the engineering operations—in which they are most extensively and commonly used, being employed so largely in mining alone that it is an almost daily occurrence for blasts containing twenty, thirty, and even fifty thousand pounds of explosives to be used in a single charge; and

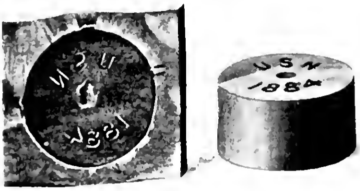
the system of large blasts has even become common in hard-rock excavations, such as quarries and railroad cuttings, while in the blast at the blowing up of Flood Rock, in New York Harbor, October 10, 1885, over one hundred and forty-one tons of rack-a-rock, dynamite, and mercury fulminate were used in a single shot.



Firing on Iron Disk, resting on Lead Disk, in testing the Efficiency of Gun Cotton.

Nor have I alluded to the use of explosives by the anarchists in their dastardly outrages, through which the safety of the old and young, feeble and strong, the innocent and the offending, are alike endangered; but I will touch briefly upon the applications of these powerful agents in the too-much cultivated industry of safe-robbing, since I was called upon some years ago to demonstrate, before a Government commission, how safes might be successfully attacked either in a burglarious way or by a mob with explosives, meaning by the burglarious operation that the safe should be made accessible within twenty-four hours with means such as a party of men could smuggle into a bank and which might be used without attracting attention or doing material damage to the building, and by "mob violence," meaning that the vaults are supposed to be in the hands of a mob which has ample time and quantities of explosives at command, and does not care how much noise is made or destruction is wrought, provided the treasure is secured.

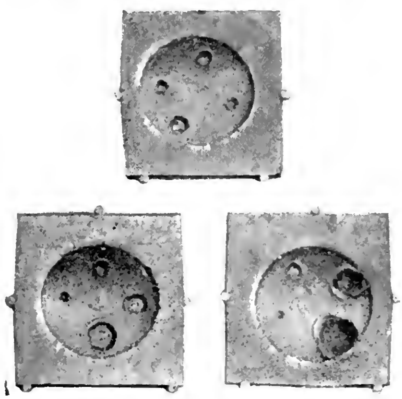
In the experiments made in a burglarious way, among others, a three-thousand-dollar square safe of the most approved construction was attacked by inserting in the crevice about the locked door four and eight tenths ounces of nitroglycerin, and in eight minutes after the operation of loading was begun the charge was fired, with the result that the whole of the jamb below the door was blown out and a hole made in the door of sufficient size to admit the hand and arm, while the doors and divisions of the interior compartments were completely shattered. On repeating the operation with four ounces and a quarter of forcite dynamite the door was completely torn off.



Gun-Cotton Disk. With indented inscription, and iron plate upon which the indented inscription has been reproduced.

Among experiments made to demonstrate the resistance of structures to attack by a mob was one upon a safe twenty-nine inches cube, with walls four inches and three quarters thick, made up of plates of iron and steel, which were re-enforced on each edge so as to make it highly resisting, yet when a hollow charge of dynamite nine pounds and a half in weight and untamped was detonated on it a hole three inches in diameter was blown clear through the wall, though a solid cartridge of the same weight and of the same material produced no material effect. The hollow cartridge was made by tying the sticks of dynamite around a tin can, the open mouth of the latter being placed downward, and I was led to construct such hollow cartridge for use where a penetrating effect is desired by the following observations:

In molding the gun cotton at the torpedo station, as stated above, a vertical hole was formed in each cylinder or block in which to insert the detonator, and in the final press a steel die was laid upon the cake so that an inscription in letters and figures was forced upon it. This inscription was indented in the cylinders and was raised upon the surfaces of the blocks. When the gun cotton was fired untamped, in testing it, the cylinder or block was usually placed with the inscribed face resting on a polished iron plate or iron disk, and after firing, if the gun cotton had detonated it was invariably found that not only was a vortexlike cavity produced below the detonator, but that the inscription on the gun cotton was reproduced on the iron plate, and, what was most singular, when the inscription was indented in the gun cotton it was indented in the iron plate, and when the inscription was raised on the surface of the gun cotton it was reproduced raised on the surface of the iron plate. In experimentally investigating this phenomenon I eventually soaked several cylinders in water, so that I could bore them without danger, and then bored holes of various diameters and depths in them, until in the last instance I bored a vertical hole an inch and three quarters in diameter completely through the cylinder. These wet cylinders were each placed on a similar iron plate, a similar dry disk was placed on each as a primer, and they were successively fired, when it was found that the deeper

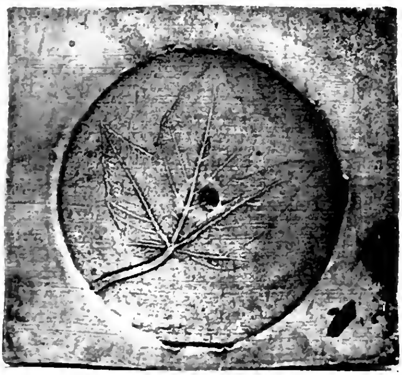


Holes produced in Iron Plates by bored Gun Cotton.

and wider the hole in the gun cotton the deeper and wider were the holes produced in the iron plate, until when the completely perforated gun-cotton cylinder, from which at least half of the weight of explosive had been removed by the boring, was fired, the iron plate was found to be completely perforated.

Advantage was taken of this action of the rapidly moving molecules to produce some beautiful effects by interposing laces, coins, leaves from the trees, and stencils with various devices cut in them between the base of the gun cotton and the iron plate, for after the detonation of the gun cotton the objects were found to be reproduced upon the iron with the utmost fidelity and in their most delicate parts, and the impressions were raised upon the iron as the objects had been before the explosion.

In one instance a disk of gun cotton was placed in a tin which had been used in canning peas. The disk was covered with water so as to be completely immersed in it, and a second dry disk, with which to fire it, was placed upon the wet one. The face of the can resting in contact with the iron plate was originally the top of the can, through which the vegetable had been introduced, and it was consequently grooved where the cover was soldered on, and it also had an irregular drop of solder over the vent hole, the solder being raised, therefore, above the general level of the face. On firing, the can was completely volatilized or comminuted as usual, but the face of the can was reproduced in every feature and with the original values of the surface, the groove being indented in the iron, and the solder being raised above the rest of the impression.



MAPLE LEAF REPRODUCED ON IRON PLATE.

In another instance a disk of gun cotton three inches in diameter was placed in a tin can five inches in diameter, and the can, which had a smooth bottom, placed on the face of an iron I-beam. The can was filled with water so as to just cover the gun cotton, a second dry gun-cotton disk was placed on the wet disk of a primer, both being in constant contact with one side of the can, and the system detonated. As a result the can and water disappeared and the face of the beam was torn off, but on recovering the pieces and matching them it was found that not only was the smooth base of the gun cotton and the face of the can reproduced in the iron, but

in the space between the gun cotton and the side of the can, occupied by the water, three distinct sets of waves were produced, having an increasing amplitude from the center proceeding outward. It is evident that many curious effects can be produced with explosive substances, and I do not doubt that useful applications will be found through a close study of the phenomena attending them.

A YEAR'S PROGRESS IN THE KLONDIKE.

By Prof. ANGELO HEILPRIN.

TWO years ago the difficulties of reaching the Klondike were thought to be of such a nature as to preclude the probability or even possibility of Dawson ever becoming a place of permanent habitation. The trials of the Chilkoot and White Passes were exploited in magazine and journal from one end of the continent almost to the other, and the wrecks of humanity, and particularly of the thousands of beasts that lay scattered along the trail—the tribute to the Sahara turned to shame—were appealed to as grim testimony of the almost insuperable barrier which separated man from the object of his search. To-day, and since July 6th of the past year (1899), a steam railway traverses the full forty-two miles of the White Pass trail, and the traveler enjoys the beauties of the subarctic landscape in much the way that he enjoys the trip through the Alleghany Mountains in the East, or of the prairies in the West. Deposited at Bennett, on Lake Bennett, at virtually the head of navigation of the mighty Yukon River (otherwise known as the Lewes), he engages passage on one of several commodious steamers heading down stream or northward, and with one change—at the Miles Cañon and White Horse Rapids, where there is a five-mile portage—reaches Dawson after a voyage, delightful in its change of scene and novelty of experience, of from four to six days. It is a fact, therefore, that with a strict timing of departures the traveler from New York may make the journey to Dawson in summer time in twelve days, and exceptionally even in less; and the journey has indeed been made in eleven days and a half. Such is the change which the effort of less than two years has accomplished.

The Dawson of 1899 is no longer the Dawson of 1898, and much less that of the year previous. The thousands of bateaux that were formerly lined up against the river front, in rows six

Note.—Acknowledgment is here made to Mr. E. A. Hegg for the use of most of the photographs accompanying this article.

deep and more, and comprising all manner of craft from the small canoe to sliced sections of scows, have mostly disappeared, and in their place we now find the graceful and ungraceful forms of varying types of steamboat. It is no uncommon thing to find five or more of these larger craft tied up at one time to the

Bartlett Brothers' Pack Train, Dawson.

river front, and the amplitude and majesty of the Mississippi boats gain but little in a comparison with some of the larger craft of the Yukon River. Overhung signs call attention to the flying queens of the river, the Bonanza King, Canadian, and Sibyl, and thousands are offered upon the result of the race to the White

Horse Rapids. So here, as in the olden days of the Mississippi, the struggle for supremacy has led to the opening of the throttle and to the scraping of the fire box. Upward of a hundred arrivals from down the river were registered at Dawson during the season of open water of 1899.

Dawson has been further put into comparatively close touch with the outer world by the entry of the telegraph, and since the early days of October messages have been freely going to the seaboard at Skaguay. It is true that a cableless stretch of hundreds of miles still separates this town from the nearest port of importance on the continent, but doubtless before very long even this blank in the line of communication will have been supplied. It may be first by means of wireless telegraphy, as it is mooted that the Canadian Government looks with favor upon experimentation with the Marconi system; or, what is more likely, the desired end will be brought about by the laying of a continuous wire. The extraordinary rapidity with which the five hundred to six hundred miles of land wire were laid—five and seven miles per day—speaks well for the *morale* of the Canadian sapper and engineering service.

In its commercial and residential aspects the city has made vast progress. The days of ingulfing mires are virtually over, and from one end of the town almost to the other, one may safely tread the streets on secure board sidewalks. Not alone the main street is furnished in this way, but also several of the streets running parallel with it, and parts of streets that run across at right angles. A wise enactment, not perhaps absolutely just in its details, has swept off the shacks and booths from the river side of the front street, and one now enjoys an almost uninterrupted view of the opposing bank of the stream, already marred by giant advertising letters announcing bargain sales in merchandise, and directing to particular shops in the metropolis of the North.

The shops of Dawson have risen to the dignity of establishments having corrugated-iron covers, plate-glass fronts, and redwood shelves and counters. Following closely upon the pioneer constructions—department stores, they might be classed—of the Alaska Commercial Company are the depots of the North American Trading and Transportation Company, the Alaska Exploration Company, Ames Mercantile Company, and the Yukoner Company, several with retaining warehouses placed beyond the reach of a city fire and with dimensions that would lend dignity to locations of much larger size than the emporium of the North. Many of the smaller shops also carry a varied line of goods, but others are restricted to a specialty, and their wares are now offered at rates which are in the main only reasonably in advance of the "high"

rates of the Western coast towns. There are exceptions to this rule, however, especially where skilled local labor is called into requisition in a manufacture. Thus fourteen dollars for a pair of trousers made to order strikes the imagination rather forcibly, when a

Dawson's Great Fire, April 26, 1899.

first-grade quality of boot or shoe can be obtained for five dollars and six dollars. Really good meals may be procured almost everywhere for from a dollar to a dollar and a half, and the best hotels supply twenty one meals for twenty-five dollars, and these do not

absolutely reject delicacies of one kind or another. Cow's milk can now be had as a regular adjunct to coffee, since the milcher is no longer a stranger to the country. The price of rooms in the hotels still remains high—from four to six dollars per night, without meals—but the character of these rooms has materially improved, even though they would be considered with us decidedly third rate. In a few establishments of a more private character, lodging for a certain amount of permanency may be had for fifteen dollars the week, or, where the condition of the surroundings is not closely scanned, for even less. A new and capacious hotel, the Hotel Metropole, reared from the wealth of the "King of the Klondike"—Alexander MacDonald—has recently been added to those of less pretentious design which served the community last year. A heavy cut in rates is promised.

The conflagration of April 26th, through which perhaps one quarter of the business portion of Dawson was burned to the ground, has given opportunity for the introduction of improvements, and the most important of these is that which has resulted in the removal of houses and resorts of evil repute from the heart of the city and consigned them and their inmates to a localized area or "tenderloin" district. Women of refinement may now parade the streets without having their finer sensibilities offended through the public intrusion of the immorals of the lower world. The tone of the public places of amusement, the theaters and dance houses, has also been in a measure elevated, even if far from sufficiently so, and some real talent occasionally sparkles behind the footlights. A new "opera house," with a seating capacity of perhaps seven hundred or eight hundred, but advertised for two thousand, was thrown open to the public last August, after a construction, it is claimed, of only two weeks. Its season's *répertoire* included, among other plays, Michael Strogoff and Camille, both of which, even in their crudest type of presentation, felt well of the public pulse.

School education plays as yet little part in the morals of the Dawsonites. The greed of fortune has left scant time for the consideration of educational matters, and what little of school training is imparted to the youth of tender years comes largely in the shape of a beneficence from private hands. If the issuance of newspapers be properly classed as belonging to education, then Dawson has made material advances during the past year, for, in addition to the three weeklies which more than supplied all the information that was needed to the inhabitants of 1898, it has now a daily (the Dawson Daily News) and a Sunday paper (The Gleaner), while the pioneer Nugget has been converted into a semi-

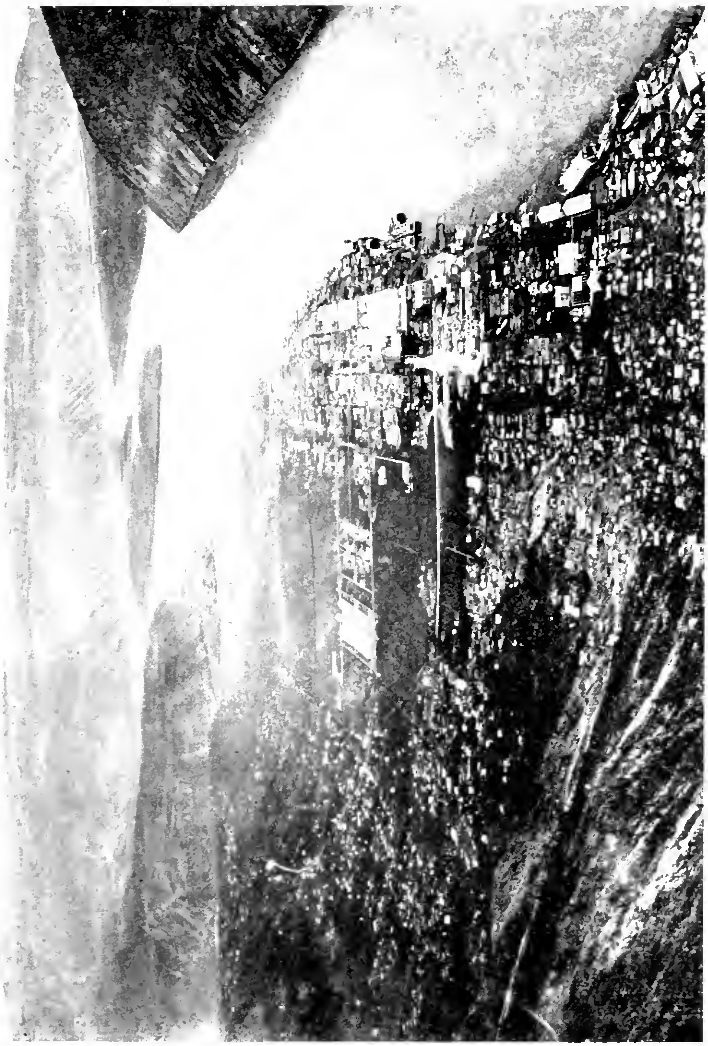
weekly. Some of these journals, which in typographical detail stand fully equal to many of the foremost journals of the United States, are devoted largely to a vilification of the Yukon government, and secondarily to the nonpartisan interests of the community. But little space is given over to murders and daring deeds of robbery, since occurrences of this kind, thanks to the continued vigilance and efficiency of the Northwest Mounted Police, are all but unknown, and the safety of possessions is as well established as that of the person. The shooting of an actress by her lover, followed by the suicide of the murderer, furnished the sensation for the year; but previous suicides, also in the ranks of the theatrical profession, had already paved a way to this form of excitement.

Two or more lines of telephone unite Dawson with the nearer mining region, and a partial city service has also been established. The city remains as yet without an electric-light plant, but it is by no means unlikely that before the present season has passed the darkness of the winter night will be lifted by the arc light, and much of the oppressiveness of the closed season thereby removed. After two winters of experience, the Dawsonites continue to think lightly of the "terrors" of the cold, and to but few apparently is the extreme of temperature a deterrent to exercise. Sleighing continues to be a pastime, with the temperature marking 40° to 50° below zero, but only with this season does it enter into the category of a fashionable recreation. Hitherto dog-sled teams performed the full service of winter travel, and divided with skating and "ski"-ing the winter exercise; but this year the snow causeways will be lively with the jingling of cutter bells and the rapid pacing of the horse.

One can not help remarking the vast improvement in the general tone of Dawson society, if by that term we may include all that constitutes the population of the city. More particularly is this marked in the case of women, among whom it is no longer a rarity to meet with strict refinement and culture. Musical *soirées* register among the events of the week, and literary recitals are not exceptional. The male portion of the population has also undergone a refining process through the departure of hundreds or even thousands of "bums," who only too late for their comfort discovered that their presence was neither a necessity to Dawson nor a mainspring to the extraction of gold from the soil. By their departure the city has probably suffered a decrease in its population of some three thousand to four thousand, but has more than received compensation in that stability of purpose which such elimination always insures. As a city of about thirteen thousand inhabitants, it enters upon its history in the year 1900 with principles

cast largely upon a pure business basis, and with a future that is bound in with the product of the soil.

The gold resource of the Klondike region seems fully to sustain the anticipations which had been put forth touching the product of 1899. The better-known creeks, such as the Bonanza, Eldo-



MIDNIGHT VIEW OF DAWSON, JUNE 21, 1899.

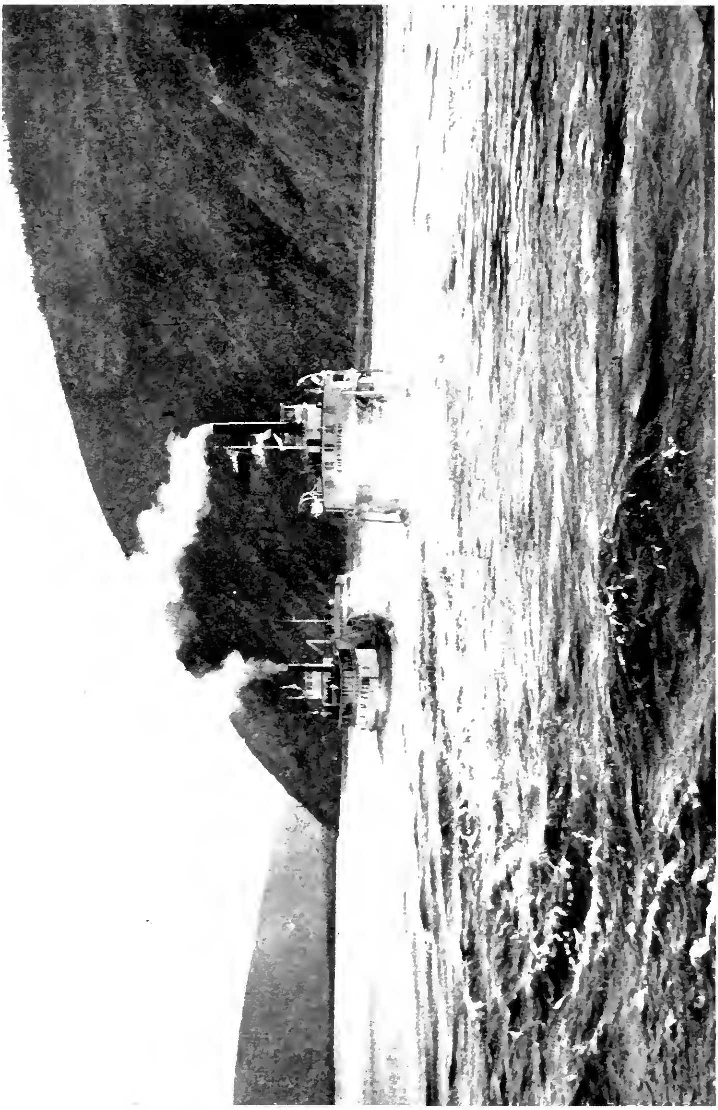
rado, and Hunker, have kept well up with their record of the previous year, and give indications of continuing as important factors in the calculation of output for some time to come in the future. The introduction of a certain amount of mining machinery, such as steam drills, thawers, and powerful pumps—applied

more particularly to the deposits of the benches and hillsides—coupled with a more definite method of conducting extensive operations on a comparatively economic basis, has given fresh impetus to the work of mine holders, and made largely remunerative that which had promised to be little profitable. A more just administration of the mining laws has helped to a considerate feeling among the miners, and reduced very materially the grievances which formerly fell with thick force upon the offices of the Recorder and Gold Commissioner. Access is now easily had to the records of claims, and individual "cases" receive an early and proper hearing. Electric plants have been introduced on some of the claims, so that there need be no interruption in work for the full twenty-four hours of the day.

Apart from the discovery of rich pay-dirt on creeks and gulches, such as Last Chance (tributary to Hunker), Gold Bottom (tributary to Sulphur), and American, Magnet, and Adams (tributary to the Bonanza), concerning which much skepticism was expressed last year, the filling in of assumed barren gaps in the general line of creeks has done much to inspire the feeling that more of the broad area is gold-bearing than the first surveys and explorations "indicated"—a feeling to which particular confidence has been given by the surprising wealth which has been washed out from the hillsides. For a nearly continuous four miles of the "left limit" of the Bonanza, extending northward from Gold Hill at the confluence of the Eldorado to the "forties below discovery," the crests of the hills at an elevation of some one hundred and eighty to two hundred feet above the creek are laid bare with the work of the shovel, pick, and drill, and the same or a corresponding stratigraphical height is pierced elsewhere along the stream. Gold Hill (and French Hill, on the Eldorado side), Skookum, Adams, Magnet, and American Hills, and Monte Cristo, all have their summits capped by what is now familiarly known as the "white layer"—a feature in the landscape as interesting to the casual tourist as the construction is important to the more fortunate claim holders who are located here.

Up to this time no quartz locations determined to be of positive value have been located, although a goodly number of "quartz reefs," "lodes," and kidney masses have been staked, restaked, and recorded. Some of these have shown gold in small quantity, but in by far the greater number of cases they have proved absolutely barren, and are without promise of yielding anything. The anticipation of many, naturally fostered by individual wish and hope, that an originating or "mother" lode must be present and found somewhere rests without any geological support so far as evidence

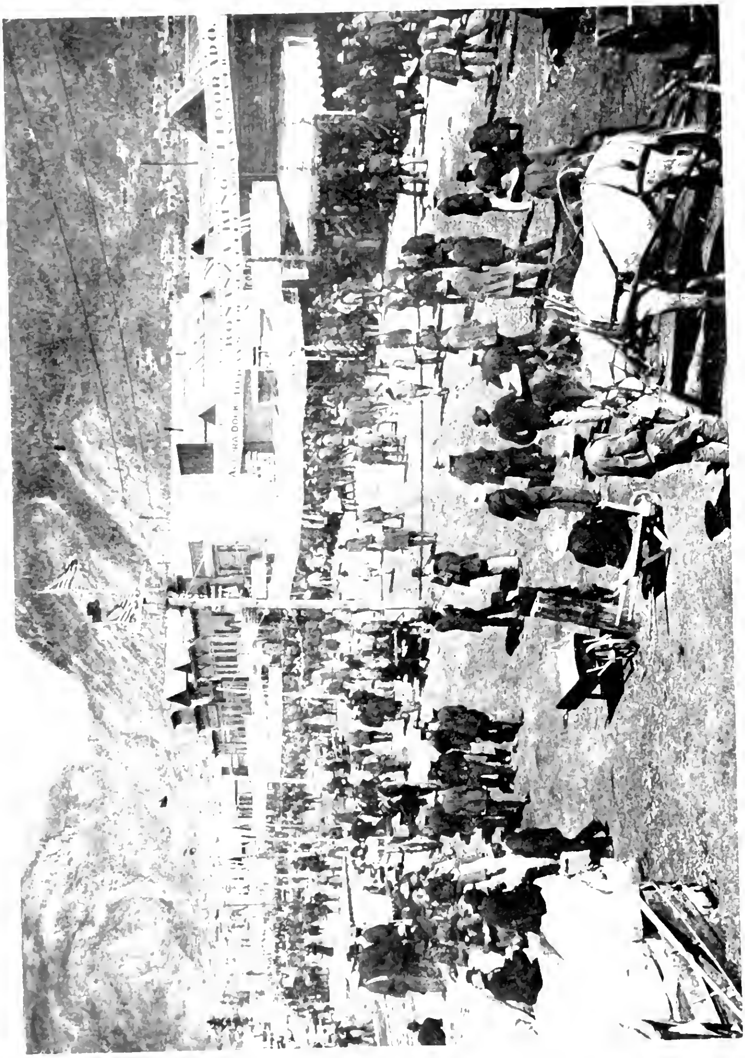
has been accumulated up to the present time, and there is nothing that looks like a promise to the geological eye. At the same time, it would be premature to assert that such a reef or series of reefs may not be discovered in the future. The hill crests that have



THE COLUMBIAN AND THE ELDORADO STARTING FROM DAWSON, JULY 4, 1899, ON A RACE TO WHITE HORSE RAPIDS.

furnished so much of the white material of the high benches of the Bonanza and the Eldorado may perhaps be searched with best advantage in this direction, and thence extended to the water parting which surrounds or incloses the upper waters of Gay Gulch.

No estimate, naturally, can yet be put to the total gold supply of the Klondike region, but to inquiry that is frequently put regarding the future existence of Dawson as an energetic mining camp one can unhesitatingly answer that this existence is assured



Street Scene, Dawson, July, 1899.

for many years to come, and there are indications that point to a permanence independent of the simple supply of gold.

The earlier conceptions of the extreme severity of the climate of the Yukon Valley forbade the hope of agricultural possibilities, but a more intimate knowledge of the conditions prevailing in the summer time a season of four to five months' duration, with day-

light and day heat protracted far into the normal hours of night—and a comparison of these conditions with somewhat similar conditions prevailing elsewhere, have given hope not alone of a possibility, but of a probability, and there are few to-day who doubt that agriculture may not be practiced with at least a legitimate amount of success in many parts of the Yukon basin. This probability has, indeed, been already emphasized by Prof. George Dawson, and the more recent examinations of Alaskan territory, made by Colonels Ray and Abercrombie, confirm with a conviction the reference to American soil. The feeble but more than promising efforts in agriculture and gardening that were made in the region about Dawson in 1898 have borne surprising fruit in 1899, and while the results may not, for various reasons, have proved in all cases remunerative to the "prospector," they at least clearly demonstrate the possibilities to which the future may lay claim. Cabbages, turnips, peas, radishes, lettuce, and beans are now raised to perfection in favored spots along the Yukon and Klondike, and on scattered hillsides of the Bonanza and Eldorado, and a good promise is also held out for the potato. In the charming spot known as the Acklin Garden, situated on the Klondike about two miles from Dawson, oats and barley, sown on April 26th and May 22d respectively (1899), were grown to beautiful heads, and harvested in the middle of August. No wheat had ripened up to that time, and I suspect that, owing to a light frost which took place on the 19th of the same month, none of this grain came to maturity. Radishes sown on April 24th were collected on May 20th, and string beans, whose seed was scattered on May 26th, were collected on August 1st. Other successful crops were those of beets, onions, and spinach.

The exquisite beauty of the flower garden in this spot rivets the attention of all passers-by, and few there are who do not for a moment lay aside their packs to enjoy the feast of color that is presented to them. Poppies of the size and brilliance of those which adorn the fields about Naples, chrysanthemums, gorgeous dahlias, pansies, the cornflower, mignonette, and centaurea are part of the outside bloom, to which Nature "beyond the fence" has fittingly added the wild rose, anemone, fireweed, and forget-me-not. Such is the aspect of the region which to-day illumines the far North, and carries with itself a hopeful promise to many and the certainty of disappointment to many more.

THE DECLINE OF CRIMINAL JURISPRUDENCE IN AMERICA.

By GINO C. SPERANZA.

THE rights of personal security, personal liberty, and private property have been called the "rights of the people of England," and may be said to constitute the richest heirloom in the Anglo-Saxon family. While, in a certain sense, they belong to all civilized people, yet, in their practical application, they are peculiarly the creation of Anglo-Saxon common sense and love of order. The underlying principle of these rights, clothed by the Latins in the seductive garb of *Liberté, Egalité, Fraternité*, gave us a Reign of Terror, a Commune, and finally a doubtful republicanism; but the same principle, embodied in the less dazzling formula, "That no man shall be deprived of life, liberty, or property without due process of law," produced in the hands of the Anglo-Saxons more enduring democracies "of the people, by the people, and for the people."

With the instinct of a race born for self-government, the Anglo-Saxons have ever sought and almost always found the highest safeguard for their ancient rights in the courts of law. Between a partisan Legislature and a tyrannical Executive an honest judiciary has generally been found ready to annul the excesses of the one and to prevent any infringement by the other; so that it has become a belief, having the force of faith, that in our courts will be found the bulwark of those liberties which we consider essential to the full enjoyment of life.

Laws and courts, however, are after all the creation of men, and, like all such creations, they are necessarily imperfect and fallible; or, more correctly, they are organisms which develop and improve. In other words, justice and law are only relatively immutable and perfect. They do, indeed, represent, in a sense, abstract perfection, and at any given time they must be considered the highest criterion of human conduct. But justice and law are not such divinities that they can withdraw themselves from the operation of those forces which we call progress. Seriousness, dignity, and venerability are not sufficient to sustain the majesty of the law; it needs also adaptation to those higher conditions and broader views which mark the growth of human thought. The more we come to look upon law as the standard and gauge of upright human action, the more do we grow to expect it in consonance with the highest dictates of human knowledge and reason, for what is above us must represent what is best in us, else it will be neither respected

nor obeyed. Whenever this consonance is not found, human belief in the dignity of the law and in the efficacy of justice ceases. For, theoretically at least, law is so near ideal perfection that the least defect destroys it entirely; and by this "ideal perfection" is meant that *laws must reflect the highest and soundest thought of every age.* Laws that fail in this cease to be a power for good; they are then looked upon either as ridiculous or as oppressive. If the former, they defeat their ends by becoming dead laws; if the latter, they become a source of disorder and discontent. Hence we see that jurisprudence is essentially evolutionary and progressive, and that the majesty of the law does not lie in its age but in its perennial youth, or, more correctly, in its successive rejuvenescence. It is true that in China the antiquity of a law is its highest prestige, but, as a consequence, Chinese justice is proverbially inefficient and barbarous. It therefore follows that the constant study and improvement of what we have called the safeguards of our fundamental rights should be our highest duty, and the object of the care and solicitude of the State. It is not enough to rest contentedly in the thought that a Magna Charta, a Petition of Rights, and sundry written constitutions protect us. Their very existence is but an argument for our eternal vigilance. Now, the question to be here examined is whether we have exercised that care and vigilance which are essential to the free enjoyment of our rights.

Let me premise the statement that the protection of the rights of life, liberty, and property is peculiarly within the province of the criminal law. What constitutes the right of life, liberty, and property can not be defined or described, except negatively by a definition of what will be deemed its infringements. These we call crimes. To declare what acts come within the definition of such crimes is the function of the criminal courts.

It is upon the criminal law, therefore, that we must rely for the enunciation of what acts shall constitute a breach of the right of life, liberty, and property, and it is to the criminal bench and bar that we must turn for the correct interpretation and application of such enunciations. Hence the more time and attention we devote to the study of criminal legislation and to the enlightenment of the criminal bench and bar, the more will the safety of our rights be increased and strengthened. Likewise, the more we allow criminal legislation to be the product of hasty consideration and the criminal bar to drift into disrepute, the more the safety of our rights will be proportionally weakened.

The first question that presents itself is, "*What is done by our law schools for the study of criminal law?*" The answer is

not very encouraging. Let us take those law schools which are of most importance, either by reason of their curriculum or of their attendance. Harvard, with a three years' course, devotes two hours a week for one year to criminal law (including criminal procedure). Allowing nine months of four weeks each to the scholastic year, and a weekly average of eighteen hours, it will be found that the time devoted to the study of criminal law (including procedure) is a little over *three per cent* of the entire course. By a similar computation we find that Columbia devotes to criminal law (and procedure) a little over *four per cent* of the entire course, which is about the percentage given by Yale and a little lower than that of the Universities of Michigan, Cornell, and New York respectively.

These computations are based upon figures given in the catalogues of those universities, or kindly furnished by the deans. Nothing more eloquent of the decline of the study of criminal jurisprudence in our country could be cited. But the catalogues of these law schools add further proof. At none of them is there a professor whose instruction is confined solely to criminal law. Nearly all the instructors in criminal law devote but a small part of their time (and probably of their study) to the teaching of this subject. In Columbia the instructor in criminal law is professor of international law and diplomacy; * at Harvard the incumbent of the chair of criminal law teaches the law of carriers; that of Michigan teaches the law of bills and notes and of public corporations; that of the New York University the law of sales and wills. It is, moreover, a significant fact that the faculties of the above-named institutions, while recommending to law students the optional study of political economy, constitutional history, taxation, physical science, English literature, and modern languages as conducive to a higher standard of legal culture, utterly fail to advise them to pursue courses in criminal anthropology, criminology, or penology. In other words, it is deemed advisable that the future lawyer should bring to the aid of his civil practice the complementary knowledge of French and history, for instance, but it is of no importance that he should be acquainted with the results of modern criminologic and penologic research. Thus the conclusion is forced upon us that the study of criminal law, whose importance I have endeavored to set forth, has become a subject at sufferance in our universities, a practically optional course

* This has since been changed; but the change makes the case worse, as the new instructor in criminal law teaches not only two branches of the law (as under last year's course), but five—viz., Criminal Law, Wills and Administration, Common-Law Practice and Pleading Bankruptcy, and Bailments and Carriers.

of little consequence to the student, and of no interest to the teacher.

From the very beginning of his legal career the future lawyer is made to feel that the field of criminal law is not the one in which to exercise his best talents. Both the school curriculum and popular sentiment strengthen this prejudice. To the community at large our criminal courts have come to mean places where criminals are sentenced or rogues saved on technicalities; they have ceased to be centers of justice, where innocent men are saved and guilty men tried according to the law of the land. Hence has arisen the popular belief (despite the rule that the accused shall be considered innocent until his guilt is proved), shared in a measure by the bench and bar, that every man accused of crime is criminal and depraved, and that, therefore, contact with him should be avoided. Thus the criminal lawyer, who necessarily must come in touch with such alleged crime and depravity, is practically ostracized not only from the community but also from the civil forum.

The existence of such prejudice against the criminal bar is most deplorable. Men of ability and position will shun criminal practice, leaving the field clear to unscrupulous shysters. Let it be remembered that to a man charged with the commission of a crime and deprived of his liberty the lawyer appears a savior; that the accused is practically at his lawyer's mercy, being under most trying duress and very easily influenced. The temptation for unprofessional dealing is here at its highest, because of the manifest advantage of the lawyer who is able, or whom the client believes to be able, to unlock the prison doors. It takes men of more than ordinary fiber to persistently resist such temptation in all its forms. Hence the necessity of upright and learned men at the criminal bar. But how few are our great criminal practitioners! How often have I heard lawyers, too young and clientless to allow themselves preferences, declare most decidedly that they were willing to do anything "except criminal law" ! They had been trained to look upon it not merely as inferior but as degrading practice. Yet it is common knowledge that in European countries, where less boast is made of inalienable rights, it is the ambition of all lawyers to get a reputation at the criminal bar. It is there, in fact, that reputations are made.

It is likewise in those countries where many would make us believe that life, liberty, and property are not as sacredly guarded as in our own country, that the criminal laws are a constant object of scholarly study and investigation. The great progress made in the study of crime, the building up of a criminal science and

a criminal sociology, is almost exclusively the work of Continental criminologists. Penology has indeed engaged our attention, but criminology has been almost practically ignored by us.

Of criminal law it was long ago said that, "by reason of the numberless unforeseen events which the compass of a day may bring forth," the knowledge of its provisions "is a matter of universal concern." Yet, despite this "universal concern," our criminal law has been and still is inferior to our civil law. I have pointed out at the beginning of this article how the majesty of the law depended essentially upon its ever-recurring rejuvenescence; that law was a living organism, subject to change and the forces of evolution.

The theories on criminal responsibility and on crime in general, in the light of modern medical, anthropologic, and sociologic sciences, have completely supplanted the old doctrines, yet criminal legislation has apparently taken no notice of them. Modern science tells us that our antiquated tests of criminal responsibility result in sending hundreds of men to prison who ought to be sent to asylums, but we do nothing to avoid this scandal. Under our system the courts are obliged to let the conclusions of the learned judges who occupied the bench three hundred years ago have more weight than the positive investigations of the men of science of our day, and so, consciously or unconsciously, numberless crimes are committed in the name of *stare decisis*. True it is that in some jurisdictions, and notably in New York, the courts have recognized to some extent the progress of science and its influence upon juridic theories. But even in these cases the concession has been made only in *civil* cases. Thus Mr. Bishop, in his Criminal Law, is obliged to point out that our courts recognize *two kinds of insanity*—to wit, *civil and criminal irresponsibility*. Why the test to be applied in the case of the validity of a will should be different from that applied in the case of murder does not seem very clear. The scientific test as to insanity has been oftentimes recognized and applied by our civil tribunals, but the criminal judges still cling with unabashed attachment to the unscientific and unprogressive rule in McNaughten's case. The Guiteau trial, which followed that celebrated decision, added fresh authority to the English view, and practically made the rule to be applied in criminal trials a legal dogma.

In an able and exhaustive paper by Mr. J. H. Dougherty on this very subject, before the Society of Medical Jurisprudence, the evils of such dogmatism in criminal law are strikingly set forth. "Life," he said, "should be as sacred as property. While society needs protection from the criminal, it does not require that the

protection should be insured through the application of a fallacious and discredited legal dogma."

This is but one example of the unprogressiveness of our criminal jurisprudence. Yet, if we really have the ancient principle of the right of life and liberty at heart we ought to recognize that this legal dogma is a greater menace to the practical abrogation of the right than the despotism of an unscrupulous executive. For while the latter is an infringement of a right which the law forbids, the former is a breach of a right which the law sanctions. Again, the theories regarding the object of penal provisions have entirely changed. Punishment has been scientifically shown to be practically useless either as a deterrent or as a correctional remedy. Yet our penal codes are confessedly based on the idea of punishment and retribution. We have indeed made some little headway, such as indeterminate sentences and suspension of judgment, but only in a scattered and tentative way.

The additions to or changes in our criminal codes have been unimportant and unprogressive. What additions are made are slipshod in their make-up, at times partisan in intent, seldom in harmony with the teachings of modern science, and oftentimes in disregard of fundamental principles. Our legislators grant "hearings" before passing a law affecting the business of a few privileged men and give it due weight; but criminal bills, which may affect the public, are generally "rushed through," probably because of an absolute lack of interest. This is but a repetition of Blackstone's complaint against criminal legislation in his day. "It is never usual in the House of Commons," he wrote, "even to read a bill which may affect the property of an individual without first referring it to some of the learned judges and hearing their report thereon. And surely equal precaution is necessary when laws are to be established which may affect the property, liberty, and perhaps the lives of thousands." And he thus concludes his observations: "The enacting of penalties to which a whole nation should be subject ought not to be left as a matter of indifference to the passions or interests of a few, who upon temporary motives may prefer or support such a bill."

The lack of public interest and of intelligent consideration by the people and the bar in criminal problems and criminal legislation are clearly shown by the paucity of criminal statistical data furnished by various States.

Penological research is based on an intelligent study of statistics, and civilized nations, recognizing this fact, have provided elaborate systems of records based on the suggestions of statistical science. But with us statistical facilities in the field of crime are

not merely primitive or old-fashioned, but in many cases shamefully absent. In reply to requests addressed to the Secretaries of State of various States for official statistics of crimes committed in their respective jurisdictions, the answers I received were in a number of cases negative. The officials mentioned replied that no statistics were published by the State in Illinois, Georgia, New Jersey, Tennessee, Kentucky, Maryland, Vermont, California, Idaho, Missouri, South Carolina, Connecticut, Texas, Wisconsin, Nebraska, Mississippi, Virginia, Colorado, and Kansas. It is true that in some of these States this lacuna is filled in by special prison reports or reports of commissioners or of the attorneys-general. But even in these cases, as well as in those published officially by the State (Ohio, Indiana, New York, Massachusetts, and Louisiana), the information furnished is a monument of antiquated methods and of very little value to the student of criminology. How, then, can we study the grave questions of crime and criminals without a basis of computation?

It may be true, as some claim, that Continental jurists have refined the criminal law to an unpractical degree and too much on classic and theoretic lines, but it will not be claimed that by adhering to an old-fashioned and obsolete criminal jurisprudence the Anglo-Saxons are safeguarding their fundamental liberties. That there is something essentially wrong, or at least antiquated, with our criminal law is evidenced by the popular discontent against it, which is too widespread and insistent to be the result of ignorance or sentiment. If there is inertia as to changes in the law it is probably because, while feeling that there is something wrong, the people either can not define it or the conservatism of centuries in this field is unconsciously affecting their better intentions. Who will deny (and I address this question to lawyers and judges) that, under our system, guilty men escape and innocent men suffer in larger numbers than it should be, even allowing for the defects inherent in all human systems?—that technicalities and not facts often save scoundrels; that unscrupulous lawyers do not avoid them, and the best of judges are obliged by legal dogmas to respect them? Who will deny (and I address this question to sociologists and penologists) that the penal provisions of our present laws are inappropriate, inelastic, and unscientific; that they neither prevent nor reform; and that the basic principle of our penal codes is still retribution and punishment? Can it be that the right of life, liberty, and property is becoming a pious fraud? Of course, it is not claimed that we have less liberty now than our fathers had three centuries ago; progress never stops, and each day is something gained; but it seems clear that the juridic basis and

form of our liberties have not kept up with the progress of those very liberties. Yet, what we call rights must have a counterpart or reflection in our laws. We may, while enjoying those rights, forget that the juridic basis on which they stand is crumbling with age. Unless that basis is rejuvenated the entire edifice must eventually fall. While we are in full possession of our rights we need no laws to guarantee them; but it is when those laws are encroached upon that there arises the necessity of juridic sanction for them.

The right of life, liberty, and property constitutes the essence of the "law of the land." But the conception of rights, as we have seen, changes and progresses. The law of the land must likewise change and progress.

Laws may be the highest and best creation of man's intellect, but they are not "hedged in by any divinity." That is why they are neither infallible nor unchangeable. Yet, as the highest and best creation of man's intellect, and as the final criterion of human public conduct, they should conform to the best thought and to the highest scientific progress. If they do not approach this standard they are worse than useless, for they become legalized means of oppression. It is then that Justice needs a bandage over her eyes, not to avoid partiality, but to hide her shame.

THE BLIND FISHES OF NORTH AMERICA.

By CARL H. EIGENMANN,
PROFESSOR OF ZOÖLOGY, INDIANA UNIVERSITY.

"An investigation into the history of degenerate forms often teaches us more of the causes of change in organic Nature than can be learned by the study of the progressive ones."—WEISMANN.

THE caves of the United States are inhabited by three cave salamanders, two of them with degenerate eyes; by six cave fishes, all with impaired vision—five of them with rudimentary eyes, one with eyes the most degenerate among vertebrates; and by several mammals. It is thus seen that among the interesting features of the North American fauna the blind vertebrates are not the least. Yet during the past twenty-five years the only additions to our knowledge, aside from diagnoses of new species, have been a few random notes on the habits and a short account of the eye of Troglichthys by Kohl.

Various classes of vertebrates have blind members, but no large vertebrate has become blind or permanently taken up its home in caves. Blatchley reports that a number of cats have established

themselves in Wyandotte Cave, where they bring forth and rear their young. They have exterminated the cave rats, and now station themselves in a narrow passage of the cave and capture bats as they fly through.

Among the permanent residents in dark places we have, among mammals, the moles, which habitually live in burrows of their own make. In Mammoth Cave lives a rat—Neotoma pennsylvanica. In Marengo Cave, Indiana, white-footed mice have established themselves. Although with unimpaired eyes, they have acquired ears and whiskers longer than the rest of their kind living outside.

Fig. 1.—The cave salamander of the Mississippi Valley (*Spelerpes maculicauda*).

In Florida occurs a blind lizard—Rhineura floridana. It burrows in the ground, and is colorless and blind.

Of salamanders, one blind species lives in European caves. In the large caves of the eastern United States no blind salamanders have been found, although other species, especially Spelerpes maculicauda, abound. In the caves of Missouri a veiled-eyed salamander, Typhlotriton, has been described within recent years by Stejneger. Still another salamander, Typhlomolge, having rudimentary eyes, has been cast up from an artesian well at San Marcos, Texas, and occurs in the cave streams about that place.

The most abundant of the blind vertebrates, both in individuals and in species, are the blind fishes. These, from their geographical distribution, may be separated into three groups: (1) Those inhabiting the depths of the ocean; (2) those inhabiting dark places along the shores of the ocean; (3) those inhabiting the underground fresh waters.

The fishes, blind or partially blind, living in the depths of the ocean bordering the American continents, are as follows: 1. Ipnops Murrayi Günther lives at depths varying from 955 fathoms to 2,158 and has the very wide distribution suggested by the localities from which specimens have been secured—viz., off the coast of Brazil, near Tristan da Cunha, near Celebes, latitude 24° 36′ north, longitude 84° 51′ west, and off Bequia. This is the only vertebrate in which no vestige of an eye has been found. Ipnops stands alone in a family. 2. The Brotulidæ have several members blind or with very much reduced eyes in various parts of the globe.

Aphyonus mollis G. and B., 955 fathoms, and Alexeterion parfaiti Vaillant, 5,005 metres, are the only ones found in the neighborhood of America. 3. The Lophiidæ are represented by Mancalias Schufeldtii Gill, from a depth of 372 fathoms. Other blind species are found in foreign waters, while others with small eyes are found in American waters. The majority of deep-sea fishes have well-developed eyes.

The shore fishes have their blind representative in Typhlogobius californiensis St., which lives under rocks between tide water on the coast of southern and Lower California. I have elsewhere described the habits of this form. In the fresh-water caves of Cuba two blind fishes—Stygicola denta Poey and Lucifuga subterraneus Poey—have been found. Their relatives live in the ocean, Brotula barbata in Cuban waters; some of the others are blind and inhabitants of deep water.

The inland fresh-water fishes are represented by Gronias nigrilabris Cope, a catfish from cave streams of eastern Pennsylvania, and by members of the Amblyopsidæ, concerning which a more detailed account is given below.

THE AMBLYOPSIDÆ.—The Amblyopsidæ are a small family of fishes allied to the Cyprinodontidæ. They are found in the Mississippi drainage basin and in certain southeastern streams. Three of the members of the family, the Chologasters, are provided with well-developed eyes, while four other species are cave fishes in the strictest sense, being blind and colorless. The distribution of the different members of the Amblyopsidæ is as follows:

FIG. 2.—The larva and adult of the Missouri cave salamander (*Typhlotriton*).

Chologaster cornutus is found in lowland swamps of the Southern States from the Dismal Swamp to the Okefinokee Swamp. Chologaster Agassizii is found in subterranean streams in Tennessee and Kentucky. Chologaster papilliferus has so far been found only in southwestern Illinois.

Amblyopsis is abundant in the cave streams of the Ohio Valley south of the east fork of White River.

Typhlichthys subterraneus inhabits the region south of the Ohio

and east of the Mississippi. A single specimen of another Typhlichthys has been found north of the Ohio River in a well at Corydon, Indiana. Troglichthys rosæ inhabits the caves west of the Mississippi in Arkansas and Missouri.

CHOLOGASTER.—Mr. E. B. Forbes secured a school of Chologaster papilliferus for me, and he wrote: "The little fishes were found under stones at the edges of the spring very close to the bluff, and when disturbed they swam back under the cliff. . . . None were found at any considerable distance from the face of the cliff." I found the Chologaster Agassizii to act similarly in the river Styx, in Mammoth Cave. As soon as my net touched the water they darted in under the ledge of rock at the side of the little pool in which I found them.

Chologaster papilliferus detects its food entirely by the sense of touch. Two which were kept in an aquarium for over a year

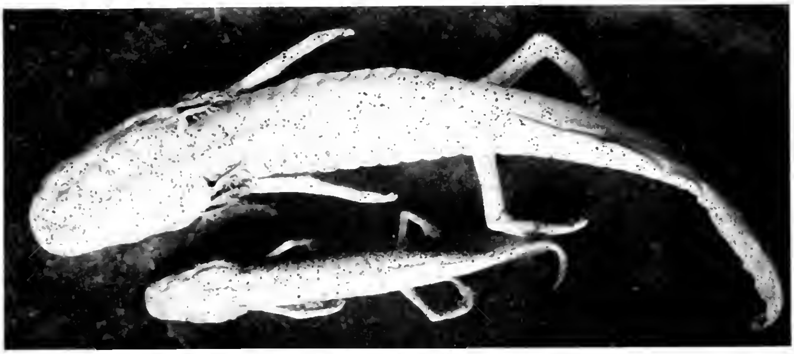


FIG. 3.—Blind salamander from an artesian well at San Marcos, Texas (*Typhlomolge*).

were starved for a few days. They became very nervous, continually swimming along the sides of the aquarium. Asellus was introduced. These, even if quite near, produced no effect if moving in front of the Chologaster. The moment one came in close proximity to the fish from any direction, by a flashlike motion it was seized. None of them were swallowed. The fish became very alert after the introduction of the sowbugs, and when swimming forward would strike at a part of a leaf if it came in contact with the head of the fish. It seemed evident that the eye gave no information of the character of the object. As Asellus was not altogether to their taste, Gammarus was introduced. One of these swimming rapidly toward the chin of the Chologaster from behind and below was instantly seized when it came in contact with the fish. The eye could not have located the Gammarus at all. The action is in very strong contrast to the action of a sunfish, which detects its food by the sight. It is undoubtedly this peculiar

method of locating and securing food which has enabled the Amblyopsidæ to establish themselves in caves.

The Chologaster in general make-up is like Amblyopsis, but is somewhat longer-jointed. It sits with its pectorals extended. When it moves horizontally for some distance the pectorals are usually pressed to the sides, the propelling being done largely by the tail very much after the manner of a salamander, which it resembles. In swimming toward the surface it uses its pectoral fins chiefly, and the fish usually sinks to the bottom as soon as its efforts to raise itself are stopped.

Individuals kept in aquaria with one end darkened either collected in the darkened area floating about, or under leaves or sticks in any part of the aquarium. They are frequently found under a floating board, where they float with the tops of their heads in contact with the board, their bodies slanting downward. They seek the dark, regardless of the direction of the rays of light. These characteristics they have, in great part, in common with the blind members of the family. The adult Amblyopsis frequently floats with its head to the top of the water, the tail sloping downward, and in swimming along ledges of rock the top of the head is applied to the ledge. I have captured many specimens simply by scraping my net along the surface of a ledge.

Typhlichthys, living in total darkness, has retained the habit of staying under floating boards, sticks, and stones. Miss Hoppin noticed that Troglichthys swims with its back to the sides of the aquarium, and I have repeatedly noted the same in the young of Amblyopsis up to fifty millimetres, and the still younger Amblyopsis frequently hides under rocks.

Amblyopsis.—The general impression given by Amblyopsis is that of a skinned catfish swimming on its back. The expressions, "They are catfish"; "They look as though they were skinned"; "They are swimming on their backs," are heard from those who see these fishes for the first time.

The largest individual secured by me measured 135 millimetres in total length. Individuals as large as this are rare. The usual length of an adult is about 90 millimetres. One individual was mentioned to me at Mammoth Cave having a length of 200 millimetres!

Amblyopsis is found in pools in the cave streams it inhabits. I have secured as many as twelve from a pool perhaps ten by fifty feet in size. Very rarely they are to be found in the riffles connecting the pools. I have seen them lying at the bottom, or swimming, or rather gliding, through the water like "white aquatic ghosts." In the aquarium they lie at the bottom or at various depths in the

water, their axes making various angles with the horizontal, their pectorals folded to their sides. When swimming slowly it is chiefly by the use of the pectorals. The strokes of the pectoral are lazily given, and the fish glides on after a stroke till its impetus is exhausted, when another stroke is delivered. The fishes frequently

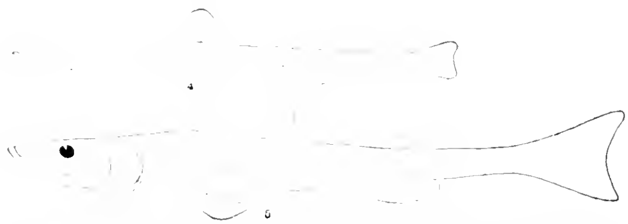


FIG. 4.—*Ipnops Murrayi*, living at a depth of 1,500 to 2,100 fathoms.
FIG. 5.—*Chlorophthalmus gracilis*, from 1,100 fathoms, off New Zealand.

roll slightly from side to side at the exhaustion of the result of a stroke. When swimming rapidly the pectorals are folded to the sides, and their locomotion is then similar to that of a salamander—by the motion of the tail. They readily adjust themselves to different depths, and are usually perfect philosophers, quiet, dignified, unconcerned, and imperturbed, entirely different from such eyed species as minnows and sunfishes which are sometimes found in caves and which are much more readily disturbed by any motion in the water, making it almost impossible to capture them when found in the caves. The pectorals are also almost exclusively used when quietly rising in the water. At such times the pectorals are extended laterally and then pressed to the sides, beginning with the upper rays. A downward stroke is delivered in this way not quickly, but with apparent lazy deliberation. In swimming the pectorals are brought forward upper edge foremost. The center of gravity seems to be so placed in regard to their various axes that the fish does not lose its balance whatever its position. They float horizontally in the water without any apparent effort to maintain their position, or with the main axis inclined upward, with the snout sometimes touching the surface of the water, apparently lifeless. Once one was seen resting on its tail in a nearly vertical position, and one while quietly swimming was once seen to leisurely turn a somersault and swim on undisturbed. At another time the same individual rolled completely over. When one of them is kept out of the water for a short time it frequently goes in a corkscrew-shaped path through the water, continually spinning around its long axis. In their quiet, floating position it is difficult to determine whether they are alive or not.

I have not found the slightest difficulty in capturing Amblyopsis with a small dip net, either from a boat or while wading through the subterranean stream, and I have caught one in the hollow of my hand. At such a time all the noise I could make did not affect the fishes found swimming in the water. Frequently they were taken in the dip net without apparently noting the vibrations produced in the water until they were lifted out of it; very rarely a fish became evidently scared. Such a one would dart off a few feet or a few inches, and remain on the *qui vive*. If not pursued, it soon swam off quietly; if pursued, it not infrequently escaped by rapidly darting this way and that; when jumping out of the water, often an abrupt turn in the opposite direction from which it started would land it in the net, showing that their sense of direction was not very acute. At other times, if disturbed by the waves produced by wading, one or another individual would follow a ledge of rock to the bottom of the stream, where it would hide in a crevice. But very frequently, much more frequently than not, no attention was paid either to the commotion produced by the wading or by the boat and dip net. In general, it may be said that the fishes in their natural habitat are oblivious to disturbances of the water until frightened by some very unusual jar or motion, probably a touch with the net, when they become intensely alert. The fact that they are not easily frightened suggests the absence of many enemies, while their frantic behavior if once seared gives

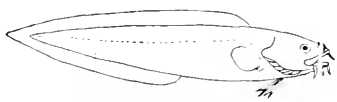


Fig. 6.—*Brodula barbata* from Havana, Cuba.

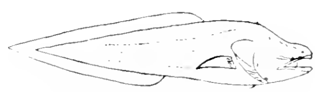


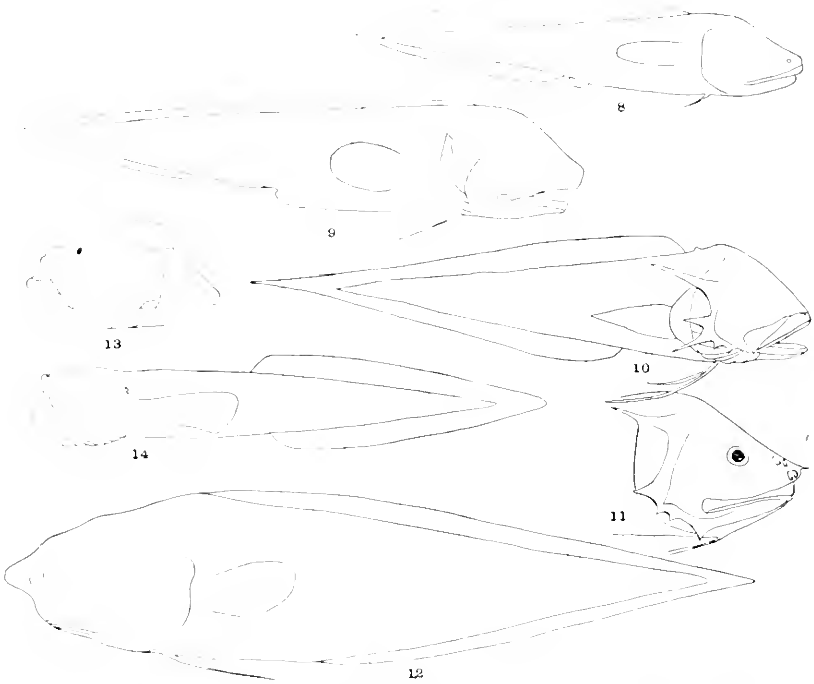
Fig. 7.—*Stygicola dentatus* from the caves of Cuba.

evidence either that occasional enemies are present and that they are very dangerous, or that the transmission of the instinct of fear is as tenacious as the transmission of physical characters.

Contrary to Sloan's observation, that they detect the presence of a solid substance in their path, I have never noticed that those in confinement became aware of the proximity of the walls of the aquarium when swimming toward it. Instead, they constantly use the padded, projecting lower jaw as bumpers. Even an extremely rapid dart through the water seems to be stopped without serious inconvenience by the projecting jaw.

The first observations on the feeding habit of Amblyopsis are those of Cope. He remarks that "the projecting lower jaw and upward direction of the mouth render it easy for the fish to feed at the surface of the water, where it must obtain much of its

food. . . . This structure also probably explains the facts of its being the sole representative of the fishes in subterranean waters. No doubt many other forms were carried into the caverns since the waters first found their way there, but most of them were like those of our present rivers—deep-water or bottom feeders. Such



8 9 10 11 12 13 14

FIG. 8.—*Aphyonus gelatinosus*, 1,400 fathoms, between Australia and New Guinea.
FIG. 9.—*Aphyonus mollis*, 955 fathoms, 24° 36′ north, 84° 5′ west.
FIG. 10.—*Tauredophidium hextii*, 1,310 fathoms, Bay of Bengal.
FIG. 11.—*Acanthonus armatus*, 1,050 fathoms, mid Pacific, off the Philippines.
FIG. 12.—*Typhlonus nasus*, 2,150 to 2,440 fathoms, north of Australia and north of Celebes.
FIG. 13.—*Hephthocara simum*, 902 fathoms, Coromandel coast.
FIG. 14.—*Alexeterion parfaiti*, 5,005 metres, North Atlantic.

fishes would starve in a cave river, where much of the food is carried to them on the surface of the stream."

The observations of Cope are entirely erroneous, as we shall see, and the speculations based on them naturally fall to the ground.

Dr. Sloan recorded one Amblyopsis which he kept twenty months without food. "Some of them would strike eagerly at any small body thrown in the water near them, rarely missed it, and in a very short time ejected it from their mouths with considerable force. I tried to feed them often with bits of meat and fishworms, but they retained nothing. On one occasion I missed a

small one, and found his tail projecting from the mouth of a larger one."

Wyman found a small-eyed fish in the stomach of an Amblyopsis.

Hoppin was struck by the fact that, if not capable of long fasts, Troglichthys must live on very small organisms that the unaided eye can not discern. Garman found, in the stomachs of Troglichthys collected by Hoppin in Missouri, species of Asellus, Cambarus, Ceuthophilus, and Crangonyx.

All the specimens of Amblyopsis so far taken by me contained very large fatty bodies in their abdominal cavity, a condition suggesting abundance of food. The stomachs always contained the *débris* of crustaceans, a closer identification of which was not attempted. One young Amblyopsis disappeared on the way home from the caves, and had evidently been swallowed by one of the larger ones. A few old ones, kept in an aquarium from May to July, were seen voiding excrement toward the last of their captivity, and their actions at various times suggested that they were scraping the minute organisms from the side of the aquarium. The young Amblyopsis reared in the aquarium seemed to feed on the minute forms found in the mud at the bottom of its aquarium. Some Cœcidotæa placed in the aquarium of the young soon disappeared, and the capture of one of these was noted under a reading glass. The fish was quietly swimming along the side of its aquarium; when it came within about an inch of the crustacean it became alert, and with the next move of the Cœcidotæa it was captured with a very quick, well-aimed dart on the part of the young fish. Others were captured while crawling along the floor of the aquarium. From all things noted, it seems very probable that Amblyopsis is a bottom feeder, and that it also picks food from the walls of the caves. It is not at all improbable or impossible that food should be captured at the surface or in open water, but there seems no warrant for Cope's supposition that Amblyopsis is a top feeder. I have frequently seen larger specimens, which had been in captivity for several weeks, nosing about the bottom of the aquarium, with their bodies inclined upward in the water and quietly taking in the organic fragments at the bottom. An Asellus stirring about at such a time always produced an unusual alertness.

The number of respiratory movements of Amblyopsis averaged nineteen a minute in five observations, reaching a maximum of thirty in a small individual and a minimum of fourteen in a large one. This is in strong contrast to Chologaster, the number of whose respiratory motions reached an average of eighty per minute in five observations, with a minimum of fifty-six and a maximum

of one hundred and eight in a small specimen. Dr. Loeb has called my attention to the more rapid absorption of oxygen in the light than in the dark; this extended would probably mean the more rapid absorption of oxygen through the skin of light-colored animals, a matter of doubtful value, however, to species living in the dark.

The gill filaments are small as compared with the gill cavity.

Oxygenation probably takes place through the skin. Ritter * has suggested the same for Typhlogobius.

"Cutaneous respiration is not unique in Typhlogobius and the Amblyopsidæ. In the viviparous fishes of California the general surface, and especially the fins, which have become enormously enlarged, serve as respiratory organs during the middle and later periods of gestation; the fins are a mass of blood-vessels, with merely sufficient cellular substance to knit them together. There is, however, no pink coloration."

FIG. 15.—*Mancalias Schufeldtii*, 372 fathoms.

Skin respiration would account for the extreme resistance to asphyxiation in Amblyopsis and Typhlogobius. About forty-five examples of Amblyopsis were carried in a pail of water four hundred miles by rail, with only a partial change of water three times during twenty-four hours. A smaller number may be kept for days or weeks—probably indefinitely—in a pail of water without change. The characteristics of Typhlogobius along this line have been set forth elsewhere.

Sticks, straws, etc., are never avoided by the fishes even when perfectly imperturbed. By this I mean that they are never seen to avoid such an object when it is in their path. They swim against it and then turn. An object falling through the water does not disturb them, even if it falls on them. A pencil gently moved about in front of them does not disturb the fishes much, but if the pencil is held firmly in the hand it is always perceived, and the fish comes to a dead halt ten or fifteen millimetres before it reaches such an object. On the other hand, they may be touched on the back or tail before they start away. They glide by each other leisurely and dignified, and if they collide, as they sometimes do, they usually show no more emotion than when they run against a stick. But this indifference is not always displayed, as we shall see under the head of breeding habits.

* Ritter, Museum of Comparative Zoölogy, vol. xxiv, p. 92.

A number kept in an aquarium with a median partition, in which there was a small opening, were readily able to perceive the opening, swimming directly for it when opposite it. This observation is in direct contrast to their inability to perceive solid substances in their path. A sharp tap on the sides of an aquarium in which six blind fishes were swimming, where they had been for a number of days undisturbed, in a dark room, caused nearly all of them to dart rapidly forward. A second tap produced a less unanimous reaction. This repeated on successive days always brought responses from some of the inmates of the aquarium. Those responding were not necessarily the nearest to the center of disturbance, but sometimes at the opposite side of the aquarium or variously distributed through it. After a few days the fishes took no notice of the tapping by any action observable in the artificially lighted room.

Such tapping on a well-lighted aquarium containing both Chologaster and Amblyopsis was always perceived by the Amblyopsis, but the only response from these imperturbable philosophers was a slight motion of the pectorals, a motion that suggested that their balance had been disturbed and that the motion was a rebalancing. Chologaster, on the other hand, invariably darted about in a frantic manner. One individual of Amblyopsis floating on the water was repeatedly pushed down by the finger without being disturbed. If, however, they are touched on the side they always rapidly dart away.

From everything observed, it is quite evident that Amblyopsis is not keener in perceiving objects or vibrations than other fishes, and ordinarily pays much less attention to them. Whether it possesses a greater power of discrimination of vibrations it would be difficult to say. It certainly possesses very elaborate tactile organs about the head. These tactile organs are probably more serviceable in detecting and precisely locating prey in the immediate neighborhood than for anything else. Some observations on young Amblyopsis are of interest in this connection.

The young, with a large amount of yolk still attached, show a well-developed sense of direction. A needle thrust into the water near their heads and in front of them causes a quick reaction, the young fishes turning and swimming in the opposite direction. They will do this two or three times, then, becoming exhausted, will remain at rest. Sometimes an individual will not move until it is actually touched by the needle. The needle must come within about three or four millimetres of the fish before it is noticed. Then, if it produces any result, it causes the fish to quickly turn and swim some distance, when it falls to the bottom again and remains

at rest. If the needle is placed behind the fish, it will swim directly forward; if at the side or about the middle, it causes the fish to swim directly forward or to turn and swim in a direction opposite the origin of the disturbance. Younger specimens have, as yet, no power over the direction of their progress; the wiggling of the tail simply produces a gyration, with the yolk as pivot.

A young blind fish, six months old, swims about in a jerky manner, chiefly by the use of its pectoral fins. It keeps close to the side of the vessel, usually with its back to the glass. (The aquarium was a cylindrical jar three hundred millimetres in diameter and three hundred millimetres high.) It perceives a stick thrust toward it as readily as a seeing fish can. It always perceives from whatever direction it may be approached, and will invariably dart away a short distance, sometimes making sharp turns to avoid the stick, and always successfully. It can be approached from the top nearer than from the sides or from in front. It does not avoid the sides of the aquarium, which it frequently strikes. It is a bottom feeder; its intestinal canal is always partially full.

A long series of experiments was made on Amblyopsis and Chologaster to determine their reaction to white and monochromatic light. Without going into the details of these experiments, it may be stated that Amblyopsis avoids the light, regardless of the direction or the color of the rays. The same is true of Chologaster, except that they were positively attracted by the red rays of the spectrum as against the blue.

We owe the first observations on the breeding habits of Amblyopsis to Thompson, who states that a fish "was put in water as soon as captured, where it gave birth to nearly twenty young, which swam about for some time, but soon died; . . . they were each four lines in length." Little or nothing has been added to our knowledge of this subject since that time, but the highly interesting supposition of Thompson that they were viviparous has gained currency, and it is therefore unfortunate that in this respect he was in error.

Putnam adds to the above that, judging from some data in his possession, the young are born in September and October, and further along remarks that they are "undoubtedly" viviparous.

The eggs are laid by the female in under her gill membrane. Here they remain for perhaps two months, till the yolk is nearly all absorbed. If a female with young in her gill pouches is handled, some of the young are sure to escape. This was observed, and gave rise to the idea that this fish is viviparous. Eggs have been obtained as early as March 11th and as late as September, and the indications are that the breeding season extends throughout the

year. The eggs are large—2.3 millimetres in diameter from membrane to membrane—and about sixty to seventy are laid at one time.

Certain structures gain an entirely new significance in the light of the breeding habits. These are the enlarged gill cavities, with the small gills, the closely applied branchiostegal membrane, and the position of the anus and sexual orifices. The latter are placed just behind the gill membrane in such close proximity to it that they can be covered by it. It is probable, therefore, that the membrane is drawn over the sexual orifice and the eggs deposited directly into the gill cavity. In an individual thirty-five milli-

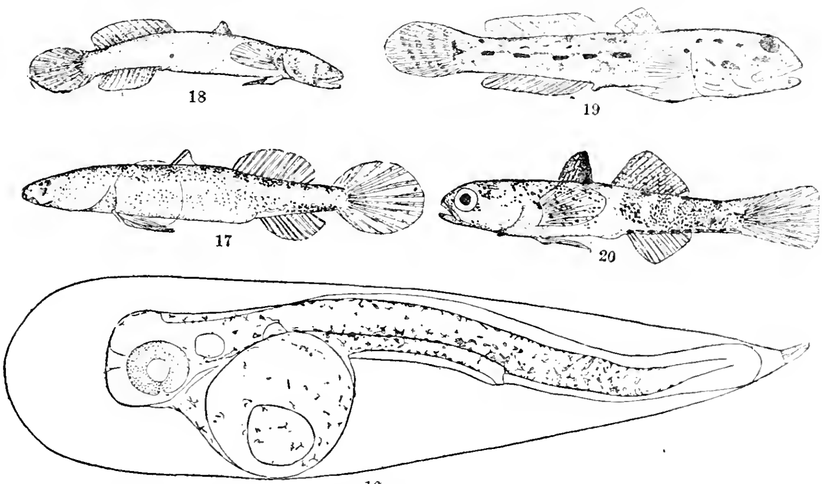


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FIG. 16.—The embryo of *Typhlogobius*, showing the well-developed eye.
FIG. 17.—A young *Typhlogobius*, times $4^{2}/_{9}$.
FIG. 18.—Adult *Typhlogobius*.
FIG. 19.—Adult *Gillichthys-y-cauda* living in crab holes in San Diego Bay.
FIG. 20.—Young *Gillichthys mirabilis* under the same magnification as Fig. 17.

metres long the anus is situated between the origin of the pectorals; in one twenty-five millimetres long it lies between the pectorals and ventrals. In the young it lies behind the ventrals, as in other fishes.

In an aquarium containing six Amblyopsis two took a great antipathy to each other. Whenever they touched, a vigorous contest began. Frequently they came to have a position with broadside to broadside, their heads pointing in opposite directions. At such a time the fight consists in quick lateral thrusts toward the antagonist to seize him with the mouth. The motion is instantly parried by a similar move by the antagonist. This blind punching may be kept up for a few seconds, when, by their vigorous motions, they lose each other and jerk themselves through

the water from side to side, apparently hunting for each other. At this time they are very agile, and move with precision. When the belligerents meet one above the other, the snapping and punching is of a different order. While jerking through the water immediately after a round, if one of the belligerents touches one of the neutrals in the aquarium it frequently gives it a punch, but does not follow it up, and the unoffending fellow makes haste to get out of the road, the smaller ones doing so most quickly. If, after an interval of a few seconds, a belligerent meets a neutral they quietly pass each other without paying any further attention, whereas if the two belligerents meet again there is an immediate response. Whether they recognize each other by touch or by their mutual excitability I do not know. At one time, in another aquarium, I saw one belligerent capture the other by the pectorals. After holding on for a short time it let go, and all differences were forgotten. The thrust is delivered by a single vigorous flip of the tail and caudal to one side. These fights were frequently noticed, and always occurred between males.

The absence of secondary sexual differences in the cave fishes is a forcible argument in favor of sexual selection as the factor producing high coloration in the males. The absence of secondary sexual differences in cave animals opposes the idea of Geddes and Thompson that the differences are the external expression of maleness and femaleness.

Attempts at acclimating Amblyopsis in outside waters have so far failed.* A few were placed in Turkey Lake, Indiana. They were surrounded by a fine wire net, to keep off other fishes. They died in a few days, as the result of attacks of leeches, *saprolegnia*, or fish mold, and from unknown causes. Others were kept in an elongated box sunk into the ground, where fresh spring water flowed through it constantly. *Saprolegnia* sooner or later destroyed all of them. They live longest in quiet aquaria, where the water is rarely changed. The young I have secured died, with one exception, within a few weeks. The difficulty of rearing the young is not at all insurmountable. They eat readily. Their aquaria must be kept free from green plants, and have a layer of fine mud, with a few decaying leaves, in the bottom. They will feed on minute crustaceans and other micro-organisms. When they have reached a sufficient size, examples of Asellus are greedily devoured. Fish mold is the bane of the larvæ. Many of them were found with tufts of the *hyphæ* growing out of their mouths and gill openings.

* Since the above was written an apparently successful attempt has been made to colonize them in a pool at Winona Lake. A record of this colony will be published later.

THE MAN OF SCIENCE IN PRACTICAL AFFAIRS.

By F. W. CLARKE.

THE human mind is addicted to the creation of types, a process which implies classification and generalization of a somewhat low order. Some prominent feature of the thing classified is selected for emphasis, and there is often a degree of exaggeration which leads, in the end, to caricature. John Bull, Brother Jonathan, the Jew of the comic papers, and the stage Irishman are examples of this tendency. So, too, a profession or occupation is summed up in one conventional character, with a little truth distorted as if seen reflected from the surface of a curved mirror. The likeness is there, but unlike the reality. The individual embodiment of the type is rarely, if ever, encountered.

The man of science deals with questions which commonly lie outside of the range of ordinary experience, which often have no immediately discernible relation to the affairs of everyday life, and which concentrate the mind upon apparent abstractions to an extraordinary degree. Accordingly, the scholar, the scientific investigator, is typified as an elderly dreamer in spectacles, who is so uncouth, so self-forgetful, so absent-minded, and so ignorant of practical matters as to be hardly more than a child. He is one to be cared for and humored, like an imbecile—treated with some consideration, perhaps, on account of his learning, but never to be trusted in the transaction of business nor in the administration of public affairs. With him, as an antithesis, is contrasted the practical man, who knows whither his steps are tending, who has learned to control others, and who never dreams of abstractions during office hours, if indeed he troubles himself about them at all. The one is thought to be vague, visionary, and unpractical; the other is deemed efficient, precise, prompt, and clear. Has this distinction any basis in reality? Do scientific pursuits disqualify a man for administrative responsibility?

These questions, like all other legitimate questions, are to be answered by evidence, and the popular impression is entitled to no weight whatever. This evidence is to be found by a study of the thing itself, the man of science as he actually is; by an examination of the training which he receives, the character of the work which he does, and the results which he accomplishes. By this method it will be found that the supposed type is purely imaginary, that the workers in science exhibit all the variations which are found in any other group of occupations, that the human race as a whole is their only symbol or representative. The man of science may

be grave or gay, moral or immoral, social or unsocial, keen or visionary—in short, he may exemplify any trait of human nature, except the traits of ignorance and stupidity. He must be intelligent and educated, methodical and exact; apart from these qualifications he may resemble any other man, chosen from any other vocation. Indeed, his nearest analogue is the so-called man of business, and the chief distinction between the two is that one deals with unfamiliar, the other with familiar things.

The direct tendency of the scientific training is to develop as fully as possible the positive traits which have been mentioned. Each science is a body of systematic, well-organized knowledge, with clear fundamental principles and distinct outlines. The study of science is a continual discouragement of obscurity or vagueness; it is a discipline in the statement and solution of definite problems, and it trains one to see things as they are, apart from all irrelevancies. The technicalities of science, so bewildering to the layman, are merely aids to exactness, avoidances of circumlocution—in short, they are practical devices whereby labor is saved. Economy of effort is one of the features in which the scientific training excels.

The results of such a training vary, of course, with the individual, and depend upon his personal peculiarities. A broad man is broadened by it; a narrow man shuts himself up within the limits of a specialty. To some extent specialization is necessary, but there is a wide difference between the man who sees only his own province and one who realizes its relations to other fields. The same distinction is found in commercial life, and with the same results. The specialist in money, in stocks, in iron, or in cotton may be just as narrow as the specialist in stars, or reactions, or insects, and know little or nothing of any subject outside his own. Neither narrowness nor breadth of view is monopolized by any vocation. The mere fact that men of science rarely devote their attention to accumulating wealth does not prove them to be unpractical. They are not, as a rule, careless or thriftless in money matters; they are as likely to handle their financial affairs intelligently as any one else, but their main business lies in other directions. If seldom a millionaire, the man of science is still more seldom a bankrupt. In wild speculation the so-called practical man takes the lead, and anything which bears the trade mark of electricity, from the electrical refining of sugar to the extraction of gold from sea water, can secure from otherwise shrewd financiers the support which a worker in science would contemptuously refuse to give. A few years ago the would-be rain-makers obtained the money for their experiments from men of business, and from Congress even, in spite of advice based upon scientific knowledge, and failure was the in-

evitable end. In that borderland between business and research, which is known as applied science, the scientific student is more practical than the financier. When both work together, wealth is produced, but the seedtime of abstract investigation always precedes the harvest. The commercial value of exact knowledge is often very great, but to the prospective investor this truth is not always evident.

The practical value of the scientific training is perhaps most fully recognized in Germany. There the importance of the investigator, the apparently abstract scholar, is thoroughly understood, and to his work the great industrial advance of Germany is largely attributable. In chemical and electrical industries this is particularly true, and their growth can be directly traced to the influence of the universities. The German professor is a man trained to research, and from among his students many of the best investigators are chosen for service in the factories. German competition in the commercial world is to-day the bugbear of other European countries, and its success is due, first of all, to the utilization of trained intelligences. In our own country the importance of applied science is fully realized and its achievements are beyond dispute, but the scholar as yet receives less consideration than the commercial expert. The latter is practical, the former is regarded as visionary. Accurate knowledge is a good thing, but rule-of-thumb experience is often thought to be better. It is only when knowledge and experience join hands that the highest practical results are attainable, the one factor tending to advance, the other to perpetuate, industry. The man of affairs is not a practical man until he appreciates the force of these propositions.

At bottom the scientific training is a training in clear thought, precise statement, accurate observation, the verification of evidence, and the ascertainment of truth. Why should its recipient be unfitted for practical things? Good administration, the effective transaction of business, implies system, exactness, the judgment of evidence upon its merits, and the prompt solution of problems as they arise, and to each of these requisites the scientific education is directly related. What other training is less likely to produce dreamers, or more likely to develop efficient men? The main distinction between the workers in science and men of other vocations is one of aim, a difference in ambition, perhaps a difference in the point of view. The scientific scholar seeks to discover and possibly to apply new truth; and after that his ambition is to win the recognition of his fellows, to gain reputation, rather than to acquire wealth. He may not be indifferent to the latter purpose, but it is not his chief end. It is difficult to do both things well.

For the administration of large interests, involving the control of men and the building-up of great institutions, men of science have over and over again demonstrated their fitness. In the scientific societies of the world they have shown their capacity for organization, and in the management of schools and colleges their ability has often been proved. Among the presidents of universities and technical schools who have been drawn from the ranks of science I may mention Eliot, of Harvard; Gilman, of the Johns Hopkins; Drown, of Lehigh; Jordan, of the Leland Stanford; Chamberlin, of Wisconsin; Morton, of the Stevens Institute; and Mendenhall, of the Worcester Polytechnic. The Institute of Technology in Boston has been directed successively by Rogers, Runkle, Walker, and Crafts; the Columbia School of Mines was built up by a group of scientific workers, aided by President Barnard; and the list might be lengthened almost indefinitely. Have these men fallen below the average of their fellows? Have they not shown at least as high administrative ability as has been found elsewhere? The mere statement of their names is a sufficient answer, and renders argument unnecessary. With them the scientific training has not been a disqualification, nor even a handicap; it has rather been to their advantage, for to it they owe much of the insight, the power to grasp great problems intelligently, the ability to interpret evidence, and the tendency to prompt and decisive action, without which successful administration is impossible.

Again, consider the scientific institutions of the world, the museums and observatories, and the various governmental organizations in which science is recognized. In our own country, the Smithsonian Institution and National Museum were built up by Henry and Baird, in spite of great and varied difficulties; the Coast Survey was created by Hassler and Bache; and the Geological Survey was developed by a group of men among whom Hayden, King, and Powell were pioneers. The last-named organization has been controlled from the beginning by men of science, and the Coast Survey has been weak only when under nonscientific management. The Commission of Fish and Fisheries owes its existence and a great part of its effectiveness to its creator, Baird; the Army Medical Museum and Library represents the executive genius of Billings; and in none of these institutions has partisan politics ever exerted an appreciable influence. No bureaus of the Government have been more wisely or more efficiently handled than those which men of science have controlled; in none have there been fewer errors or scandals; there is not one in which the essential purpose of its existence has been better fulfilled.

Instead, then, of excluding the scholar, the investigator, the

man who knows, the man of scientific training, from his fair share of public responsibility, we should do well to call him into service more and more. He may be, he often is, averse to administrative work, for the reason that it interferes with his chosen occupation, and hinders the prosecution of research. But his training and his mental bias are both needed in public affairs, wherein the scientfic method is too often unapplied. In European countries men of high scientific rank are frequently found in legislative bodies and ministries; men like Playfair, Roscoe, and Lubbock in England, Virchow in Germany, Quintino Sella in Italy, and Berthelot in France. With us in America the maker of speeches outranks the thinker in popular esteem, and is given duties to perform in which he may become ridiculous. Both in legislation and in diplomacy many questions arise which demand the most careful scientific treatment, or which can be answered only by thorough scientific knowledge, and many of these have been intrusted for settlement to men of no specific training whatever. Of late years we have had the fur-seal controversy, the question of forest reserves, the irrigation of our arid lands, problems of sanitation and water supply, and in each of these the man of science has played a part which was too often subordinate to that of the politician. In an ideal government the two should work together, each supplementing the peculiar ability of the other. Many details of the tariff, and a notable part of the coinage question, require scientific data for their proper settlement, but the true expert has not always been consulted. The result of this neglect is sometimes seen in courts of law, where questions of interpretation arise which might have been averted, obscurity in legislation being often due to the careless use of scientific terminology or to ignorance of the relations in science between two branches of industry. The voice of the trained investigator might well be heard in Congress, but his testimony now is limited to the committee room. Even there it is received with an attention which is too often mingled with incredulity. The myth of the dreamer, the visionary, is more than half believed.

The supposed type, then, is not a type, but an exception—a man of straw, which is hardly worth overthrowing. But the belief in it has been and still is mischievous, a hindrance to wise action, an obstacle to progress. The misconception has worked injury to science. These words of protest, therefore, are not wholly superfluous.

FORENOON AND AFTERNOON.

By CHARLES F. DOWD, Ph. D.

IT is a fact of common observation, at different times of the year, that the forenoon and afternoon, as to daylight, are of unequal length. Along in later autumn the shortness of the afternoons is very noticeable, and the shortness of forenoons along in later winter. Whatever makes common facts more intelligible adds to the general intelligence and to the general good. It is to this end that the following brief statements are made.

Nothing is more evident than that the sun requires just as much time to go from the eastern horizon to the midday meridian as to go from that meridian to the western horizon. But, strange to say, there are but four days during the whole year in which the sun reaches the midday meridian at just twelve o'clock. The true noon point varies from about fifteen minutes before to about sixteen minutes after twelve o'clock. These extreme points in one set of variations fall in the first week of November and in the second week of February, not to designate exact days for years in general.

The calendars show that in the latitude of Saratoga (essentially Boston latitude) on November 3, 1898, the sun rose at 6.30 and set at five o'clock, thereby making the forenoon a half hour longer than the afternoon. On that day the sun reached the midday meridian at 11.45. On February 13, 1899, the sun rose at just seven o'clock and set at 5.30, thereby making the afternoon a half hour longer than the forenoon, and on this day the sun reached the midday meridian at 12.15. These are facts plainly open to general view, and therefore need no verifying.

The causes of the foregoing are not so apparent to common observation. It must be borne in mind that the mean or average solar day is the basis for all time measurements, therefore its exact length is of the greatest importance. Yet the general solar day, from which the average one is derived, is a very indefinite term as to its length. Its length in general may be defined, under view of the sun's apparent motion, as the time extending from the instant that the sun's center crosses any given meridian of the earth on one day to the instant that center crosses the same meridian on the following day—i. e., the time intervening between these two instants is the length of a solar day.

The motion of the sun, however, is only apparent; the actual motion is in the earth's revolution upon its axis. We should have one day a year long if the earth did not revolve on its axis at all,

since the revolution of the earth around the sun once a year would in the course of the year bring all sides facing the sun. Consequently the earth makes one more revolution upon its axis each year than the number of solar days in that year, and a little consideration of this fact will show that in each solar day the earth makes one full revolution on its axis and about $\frac{1}{365}$ of another, which fractional addition is occasioned by one day's progress of the earth along its orbit.

Another fact needs to be considered. Since the earth's orbit is in the form of an ellipse, with the sun at one of the foci, the earth must pass nearer the sun in some parts of its orbit than in others. By the laws of gravity, when nearer, the attraction between the earth and sun is greater, and if this were not balanced by increased velocity along its orbit the earth would fall into the sun; and, on the other hand, when farther off this attraction is less, and if this were not balanced by a diminution of velocity along its orbit the earth would fly off into space. This varying velocity, together with other complications too technical for a magazine article, gives varying lengths of orbit to the several solar days of the year. If the earth's orbit were laid out upon paper and, by astronomical calculations, an exact proportionate section were marked off for each solar day of the year, the variable lengths of orbit for the different days of the year would plainly appear to the eye.

But, as before explained, the time of a solar day is the time of one revolution of the earth upon its axis, together with the fractional part of another revolution occasioned by one day's progress of the earth along its orbit. Then it must follow that as the daily sections of the orbit vary in length, the time of the solar day must vary in length. No clock could be made to keep the variable time of true solar days, and if this were possible, the hour, minute, etc., would be variable of length, and hence no standard for time measurements. But by working a simple arithmetical problem of addition and division an average length of day for the year may easily be found. This average day is the mean solar day adopted. Its time is arbitrary and exact, forming a perfect standard for all time measurements. From this the term *mean time* gains its significance.

By referring to the foregoing earth's orbit laid out on paper, with the true solar days marked off in sections of mathematical exactness, it will be seen that by dividing each section into two equal parts and marking the division point with red ink, the true noon point of each solar day in the year will be conspicuous upon the drawing, and in its proportionate relations in every way. If now we set a pair of dividers or compasses so that the opening shall

reach over the exact space on the orbit of one half of the mean solar day, and beginning at the red noon point of one of the four days in the year when the true noon falls at just twelve o'clock—say December 24th—and step the dividers around on the orbit, making a blue point mark at each second step, then as the blue points vary from the red so will the mean time which our clocks keep vary from the true noon of each day of the year.

Variation in length of forenoon and afternoon, therefore, may be viewed by common intelligence not only as a fact but as a necessity.

PRESIDENT JORDAN'S "NEMINISM."

Office of the President, Leland Stanford Junior University,
Palo Alto, Cal.
Post Office, Stanford University.

Dear Dr. Youmans:

The inclosed, from an anonymous but appreciative source, may interest you. It is doubtless true that the philosophy of Neminism goes back to India, through Hegel and Plato, but the high priestess does not know this. She made it all out of her own head.

Truly yours,
David S. Jordan.

The University of Mentiphysics,
Lynn, Mass., *December 6, 1899.*

President David Starr Jordan, Leland Stanford University, California.

Sir: I have before me the last issue of one of our two or three great scientific magazines, in which Mr. Giddings lays down the exact method we are to follow in sociology, thereby creating the pleasing impression that hereafter he intends to stick to it himself. But, sir, I wish to say, as a student of "Neminism," as you call it, that my emotions were far less agreeable on perusing your brilliant plagiarism, the doctrine of *Nihil nemini nocet,* an aphorism which apparently you wish to make rival the *Cogito ergo sum* of the Cartesian philosophy. I will concede to you (I being, as it is perhaps necessary for me to remark, a literary person) the undoubted right all real literary persons have of appropriating everything of a literary nature that they can lay their hands upon; but, while we are in perfect harmony upon this occasion, in regard to that point, I regret to insist that the thing must be done judiciously—*that* is the art. Any mere plebeian can accumulate facts—*that* is the *raison d'être* of the plebeian; his duty is to work—but the real ethereal literary man, such as the monthly magazines nourish, must

disdain facts and theories and the truth, and must float in the pure, soft twilight of his own imagination while he writes about people who never existed, in a language which nobody can understand. Yet, sir, in your unblushing appropriation of the late Professor Hegel's dictum of *Sein und nicht Sein sind dieselbe* (which I presume you, sir, to exculpate yourself, will swear you do not understand), and in your changing that immortal antithesis to your *Nihil nemini nocet*—in doing all this I declare that you have violated one of the most sacred principles, in fact, the very essence of Neminism; for to say, as you have said, that nothing hurts nobody, is to say a very dull, prosaic, vulgar fact which any fool can understand; but to say that "to be and not to be are the same" is to say something that is not only very beautiful, but, what is far more to the point, is likewise utterly incomprehensible; yet to do this *is* the essence of Neminism, as you yourself have shown.

As a confirmed Neminist glorying in his Neminism, as Pascal's Father Joseph, the Jesuit, gloried in "interpretation" of the words "murder" and "charity," I am, sir (and I hope my frequent use of this monosyllable will not annoy you, for the first Neminist, Plato, uses Ω Σωκρατες quite as frequently, though his expression requires four times as much wind or space as mine), I say, then, that I am always anxious to be thought well of by people who are on top or are getting there, in order, to use your own undignified and cruel metaphor in the Rev. Mr. Lyman Abbott's journal of news and Christianity, that I may continue "to hold down" my position as the janitor and Professor of Leibnitzian Monadology in the University of Mentiphysics. But there are times, sir, when even a Neminist rises above his interest, and, like Richelieu in the play, exchanges the lion's and the fox's skins. In short, I beg to inform you that I believe that you, seeing the growing attachment of the vulgar mob for the *Wissenshaftliche Pädagogie* of the Robinson Crusoeans or concentrationists, have had the thought to sap the foundations of their success by vulgarizing our noble monopoly of Neministic science, and I should not be at all surprised to see your name, after a little, as the editor of a "Journal of Psycho-Materno-Kinder Apperceptics," or of a strictly American "Great Educator Series," beginning with Pontiac and ending with Jim Fiske.

Or perhaps, sir, you are actuated by deeper motives. Our university has not yet received the complimentary copy of your work on Imperial Democracy, the Government probably holding it back until General Young can catch Mr. Aguinaldo, but I see by the publishers' lists that it is out. Now, it is easy to see that if Imperial Democracy gets within a stone's throw of China it will get *into* China, and, with your knowledge of Aristotle's Politics and the

Highbinders in Chinatown, you can not have failed to have recognized that Neminism and Orientalism are very similar. To be or not to be; to be alive or to be dead; to be drunk or to be sober—'tis all the same for the people; 'tis *Nirvana*. You wish to vulgarize Neminism. What follows your success? Immediately every State will make it an obligatory study in the public schools, and when, in the distant future, we meet the Chinamen face to face, we will be ready to exterminate them or be exterminated by them; for it is an axiom of sociology, which it is to be hoped Mr. Giddings will see the value of and will in the next edition of his Social Euclid make number one, that when two societies completely differing in origin, history, manners, institutions, and laws come together they start in the more quickly to cut each other's throats when they have a common idea in which they can locate a difference, and hence find a logical excuse to begin.

I would have preferred that our president had taken up this unpleasant task of criticising your mischievous efforts to vulgarize our beautiful science, which, like the true religion of the Egyptians, should be retained *sub rosa* in the temples; but she, as you yourself have said, does not like controversial publicity, and has often remarked that our science is like the mushroom, for, though it is the child of darkness and Byzantian filth, it is eminently adapted to be retained by weak stomachs, while for others it may be nauseating. I am, sir, very respectfully,

ANACHARSIS PANGLOSS, *M. Plane.*

Though religiously refraining from introducing my own personality in the foregoing, it being a cardinal point in our science that it is good form to appear modest—*videri quam esse,* as was said of Cato—I am, nevertheless, obliged to observe that I am not at all in any way related to the Dr. Pangloss, LL. D., A. S. S., mentioned in the play of the Heir at Law, nor yet, though perhaps more spiritually akin, to that other Dr. Pangloss—Dr. Leibnitz Pangloss, the tutor of Candide mentioned by the late Monsieur Voltaire of happy memory. Dr. L. Pangloss, a fine old fellow at bottom, was engaged in showing how, in the best possible words, a cause always precedes its effect; for instance, Monsieur the Baron Thunder den Trockendorf has a nose, argues he—it will carry spectacles, hence the nose was created for spectacles, and spectacles are created. It is plain that Dr. L. Pangloss was a scientist. Now, I am a sociologist, and it is the hope of my life to fill the chair of Monadology in the new American university, where I intend to show that while the rich are becoming richer the poor will become richer than the rich in contemplating how much more satisfaction the rich get out

of their riches than they, the poor, get out of their poverty. This, as you will at once recognize, is in the line of what Mr. Lester Ward calls Dynamic Sociology, and, though it is not the acme of the application of dynamics such as that which knocked Hebraism out of Saul of Tarsus, I beg to remind you that, until German science has made further progress in the application of electricity, we lack the means of producing the necessary phenomena by which alone such effects can be secured. A. P.

Correspondence.

FAITH AND KNOWLEDGE.

Editor Popular Science Monthly:

SIR: In your editorial, in the issue of September, you speak of "faith as the organ of religious apprehension." This suggests some important facts that are not always apprehended, or are forgotten. There is no organ for the discovery, the proof, or the apprehension of truth but reason, whether facts of Nature or of religion. "Faith" is not a sixth sense which we do not use in scientific pursuits, but which comes to our help when we seek for religious truth. Much of the difficulty comes from the fact that the word "faith" is ambiguous, having two meanings, which are not distinguished. It is (1) simply belief of a fact because of evidence presented to and apprehended by the reason; or is it (2) trust, confidence in, belief in, as in a person, resting on the belief of that person's competency and truthfulness, that belief resting on evidence apprehended by the reason. Because of this "faith" in the person we accept his testimony as to facts beyond our personal cognizance, we believe them not because we have discovered them, or may be are competent to discover them, but because of our "faith" in a person whom we have seen reason to believe is trustworthy—i. e., competent and truthful.

Now, these two meanings of "faith" are often confused, interchanged. Hence the discredit thrown upon belief of religious truth, because an illegitimate use is made of the place of "faith" in its justification. And writers defending religious belief have been great sinners in this illegitimate use of "faith."

The place of "faith" is the same in science as in religion—i. e., it is the condition and justification of our acceptance of truth which is beyond our personal cognizance. We accept it because of the testimony of men in whom we have learned to have faith—e. g., How few of us who accept the revelations of the spectrum analysis as to the composition of the stars have any other justification for accepting them than just this? We believe them simply because men, whom we, in the exercise of our reason, have come to believe competent and truthful, tell us what they have seen. We believe on their testimony because we trust them. Our process involves three steps: (1) Belief of their competence through appeal to reason; (2) trust in them because of this belief; (3) belief of their testimony because of this trust or "faith" in them. The only organ we have used is reason, in its initial act of belief of the competence and truthfulness of the witnesses. Error in the use of reason here vitiates all that follows. Correct use of reason here gives a legitimate condition for correct results of the other steps. But reason must go along with us and guide us in these, that we may come to a rationally accepted belief of the truth.

Here is the place of "faith" in science, as belief and as trust. By its use we accept the great issues of scientific truth which we believe, and do it legitimately.

It is the same in all right acceptance of religious truth. Here appears a person in human history claiming to reveal facts beyond our sphere of cognizance. Now, the first (1) step is belief in his

competence and truthfulness as a witness, just as in cases of science. His only appeal is to reason, our only organ for apprehending truth. We, because of the evidence presented to our reason, believe him competent and truthful—i. e., trustworthy—and we take the second step (2), as in case of search for scientific truth. We trust him, we have "faith" in him. Then (3) we believe his testimony as to facts beyond our cognizance, as to God, as to the inner world and life, as to his own person and work, and his agency in helping us to the true life. Here are the same three steps as in our believing the great facts of science, and they are equally legitimate, and the belief is equally legitimate, and with the same use of "faith" in both cases, which use is legitimate if we have applied our reason correctly.

It may be said that there is this difference in the two cases: We are, it may be, competent with training to perceive with our reason the facts to which the scientists witness, whereas in religion we are not competent by any training, in our present state, to see what Jesus Christ testified to; therefore the believing him is not legitimate.

Space forbids arguing this point, but the writer is confident it can be shown that this does not vitiate the process in the least. The only point now argued is that reason is the only organ of man for the apprehension of truth, and that "faith" acts the same part in scientific and religious belief.

John R. Thurston.

Whitinsville, Mass., *September 30, 1899.*

[The point which our correspondent discusses is one which falls rather within the province of theology or philosophy than within that of science. In the article to which he refers we did not distinctly say that "faith" was "the organ of religious apprehension." What we said was that *granting* such was the case, the question still remained to be settled where the line should be drawn between faith and knowledge. We doubt whether the account which our correspondent gives of faith would be widely accepted by those who approach the subject from the theological side, while those who approach it from the scientific side would—at least many of them would—be disposed to consider the term one which might better be dispensed with in favor of the less ambiguous word "belief." Belief is the inclination of the mind toward a proposition for which absolute or demonstrative proof is wanting, and it is this condition of mind, it seems to us, that our correspondent has in view. Faith in the religious sense, unless we are mistaken, is something different. It is an affirmation made by the human conscience or consciousness in its own behalf—a certain instinctive recognition of a presence and power in the universe which, though inaccessible to scientific investigation, sustains an intimate, profound, and all-essential relation to man's moral nature. If trust in an individual ever rises to the level of faith in this sense, it is because the influence of the individual harmonizes with and re-enforces the primal instinct. That, at least, is how we view the matter.—Editor.]

FISKE'S VIEWS COMPARED.

Editor Popular Science Monthly:

Sir: Will you permit me to say a few words supplementing your review of Through Nature to God? To those who have perused Mr. Fiske's latest three scientifico-theological booklets, and also his Cosmic Philosophy, it can not be new that their author has become entangled in hopeless contradictions of himself. The limited space of a letter does not allow of adducing more than one remarkable passage from Cosmic Philosophy, demonstrating the antithesis between the arguments of this work and Mr. Fiske's latest opinions, these new thoughts having been developed, as he tells us, by "carrying such a subject about in his mind for" twenty-five years. We are told in Through Nature to God (page 12) that "it has usually been found necessary to represent the Creator as finite either in power or in goodness, although the limitation is seldom avowed, except by writers who have a leaning toward atheism and take a grim pleasure in pointing out flaws in the constitution of things. Among modern writers" Comte and Mill are conspicuous for such a "leaning toward atheism." Then we are informed (page 20) that the "shock which such a clear, bold statement gives to our religious feelings is no greater than the shock with which it strikes counter to our modern scientific philosophy." And a little further on we find that "the God which Mr. Mill offers us, shorn of the attribute of omnipotence, is no God at all."

If the reader will now open Cosmic Philosophy, he is told in vigorous language (vol. ii, p. 405) that "if there exist a personal Creator of the universe who is infinitely intelligent and powerful, he can not be infinitely good; if, on the other hand, he be infinite in goodness, then he must be lamentably finite in power or in intelligence. By this two-edged difficulty, theology has ever been foiled." Then (vol. ii, p. 406) Mr. Fiske, quoting from Mill, expresses his entire concurrence with the views of this eminent thinker, and adds (vol. ii, p. 407), "With Mr. Mill, therefore, 'I will call no being good who is not what I mean when I apply that epithet to my fellow-creatures.' And, going a step further, I will add that it is impossible to call that being good who, existing prior to the phenomenal universe and creating it out of the plenitude of infinite power and foreknowledge, endowed it with such properties that its material and moral development must inevitably be attended by the misery of untold millions of sentient creatures for whose existence their Creator is ultimately alone responsible."

No comment of mine can show more clearly than the passages cited above the "conversion" of Mr. Fiske, against which imputation so much subtle ingenuity is expended in the preface to The Idea of God.

That Mr. Fiske is merely reviving gross anthropocentric views he himself admits. To him, man is "the goal toward which Nature's work has been tending from the first." But might not also some pithecoid ancestors of ours have deemed themselves the "goal toward which Nature had been tending from the first"? What is Nature's goal in the endless cycle of evolution in which life is but an infinitesimal part? But with Huxley I believe that "it would be a new thing in history if *a priori* philosophers were daunted by a factious opposition of experience." Mr. Fiske's latest writings, as all theodicies, bear testimony to the truth of Huxley's scathing remark.

But granting, for the sake of the argument, that "in the deepest sense it is as true as it ever was held to be, that the world was made for man," there is an objection to be raised on moral grounds stronger than any that could be founded on scientific arguments. Had this world been created for man, entailing, as it does, the "misery of untold millions of sentient creatures," who but the crassest egotist could worship this Fiskean God of iniquity?

The careful student of Thomas Huxley's works may be surprised to find Through Nature to God "consecrated" to the memory of him whose life work was devoted to "untiring opposition to that ecclesiastical spirit" that shines through every page of Mr. Fiske's latest writings. I echo Mr. Fiske's words: "I can never cease to regret that Huxley should have passed away without seeing my [Mr. Fiske's] arguments and giving me the benefit of his comments." The last stroke of Huxley's pen was giving Mr. Balfour "the benefit of his comments"; would that he could have given them to the author of the excursion Through Nature to God!

B. A. Behrend.

Erie, Pa., *December 5, 1899.*

Editor Popular Science Monthly:

Sir: Your trenchant criticism of Mr. John Fiske's discussion of the mystery of evil recalls Mr. Spencer's reminder that "there is a soul of truth in all things erroneous."

Mr. Fiske certainly has not made it plain that the meaning of the universe is to be found (exclusively) in the higher developments of love and self-sacrifice; but is it not equally a mistake to say inferentially that "on a broad view of the world-wide struggle for life there are no moral elements to be seen"? If we define morality as the equivalent merely of love and self-sacrifice, the ever-present love of mother and, in a degree, of father for the offspring imperatively negatives such a conclusion.

But morality is something more than love and self-sacrifice. Morality is right conduct, and right conduct in the last analysis is conformity to the conditions of existence. The nearer the conformity, the more complete the life, and life approaches completeness only as the activities of men cease to be impeded by each other's aggressions, the highest life being reached when men help to complete one another's lives.

Conversely, evil must be defined as nonconformity to the conditions of existence. Slowly but surely man is learn-

ing these conditions, and as he learns it is not to be doubted that "evil" will lessen. If we affirm acquisition of knowledge by man, we must postulate a precedent or "necessary" condition of ignorance. Hence it may be truthfully said that evil *is* a necessary correlative, and in a manner the necessary condition of good; and also, I think, that a broad view of the world-wide struggle for life shows not an absence of moral elements, but rather that the ethical is inherent in the very nature of animate things.

We may not all share Mr. Fiske's exuberant optimism, and many can not accept his teleological implications, but of the ultimate triumph of good over evil, of knowledge over ignorance, we may not doubt. FRANK M. LOOMIS.

BUFFALO, *November 10, 1899.*

THE LOCATION OF VINLAND.

Editor Popular Science Monthly:

SIR: I beg to take exception to the exploded Boston theory again revived by Miss Cornelia Horsford in the last number of your valuable magazine. It is astonishing to notice how little Prof. G. Storm's excellent prize essay and Mr. Reeve's careful edition of the text of sagas seem to have availed against the misplaced patriotism that persists in carrying those Norse explorers down to New England in the face of the numerous difficulties with which this feat is associated. If I am not mistaken, not a single historian or antiquarian of note has taken Professor Horsford's extremely unscientific treatment of the sagas or his Norse discoveries seriously, and the sober verdict of Mr. Thorsteinn Erlingsson and Dr. V. Gudmundsson on the alleged Norse ruins seems to show that Miss Cornelia Horsford has met with no better success. To refute all the philological curiosities and illogical conclusions drawn by Professor Horsford in his ten treatises on the subject would, however, require a book of at least five hundred pages, and nobody seems to think the question important enough to warrant such an output. The fact that Mr. A. H. Keane, in his recent work, Man, Past and Present, takes it for granted that the Norsemen met with Eskimos in New England in the year 1000 seems to prove, however, that this persistence in defending a baseless supposition is not merely a matter of innocent patriotism. Fortunately, the current year, which marks the nine hundredth anniversary of the discovery, will be sure to see some valuable new treatises on the subject, and those who are sufficiently interested furthermore need only consult the above-mentioned books to discover how many serious objections the New England theory really has to contend with. Permit me to mention one of them. Cape Cod has, it is true, one singular feature that suggests the Keel Cape of the best version of the Vinland manuscripts—viz., sandy shores. As everybody can see for himself, however, by consulting Mr. Reeve's book, the explorers sailed south from Keel Cape on the eastern shore till the country became indented with bays. At the mouth of one of these they established their first winter quarters (the so-called Streamfirth), and the next fall proceeded still farther south for a considerable time till they came to "Hop," the true Wineland. The extraordinary ease with which Professor Horsford, in his book Landfall of Leif Ericson, undertakes to chop up this version, in order to make the explorers return to Boston from Cape Cod instead of continuing on their course, is something remarkable in the annals of historical research. But even then his theory fails utterly to satisfy the critical reader. The trouble with most of the writers on this subject, not excluding a professional historian like Prof. John Fiske, is that they have failed to sift the material or see the force of Professor Storm's criticism of the Flat Island version. This being done, everything falls into line for the Nova Scotia theory, due consideration being given to the fact that an oral tradition of at least one hundred years intervened between the events narrated and the first somewhat extended written record.

While, therefore, owing to the last-mentioned fact, it is not altogether impossible that the Norsemen reached New England, it should be distinctly understood that such a conclusion can only be drawn on archæological lines, the test of the sagas pointing clearly in the opposite direction.

JUUL DIESERUD.

FIELD COLUMBIAN MUSEUM, CHICAGO, *December 7, 1899.*

Editor's Table.

THE WAR SPIRIT.

IT must be a matter of deep regret to all right-thinking men that there should have been during the latter half of the century now expiring so marked a revival of the war spirit. In the middle of the century it was thought by many that the world had learned wisdom from the terrible experiences of the past, and that with the development of international trade war would become an outworn mode of settling international controversies. How different a turn things were destined to take need not here be told. Coming to recent events, however, we may say that it is lamentable our own country could not have won by peaceful means whatever advantages it has secured by its recent war with Spain. Equally lamentable is it that Great Britain, the other great representative of Anglo-Saxon civilization, should at this moment be engaged in a still bloodier struggle over questions which it is hard to believe could not have been settled by negotiation. "Whence come wars and fightings among you?" is a question that was asked very long ago, and we do not know that it is possible to improve on the answer then given: "From your lusts."

We do not say that a nation should not resist to the death a distinct aggression on its liberties or its independence. We do not say that when horrors are being enacted in any part of the world force may not righteously be employed to arrest them; but it is clear to our mind that, in the present age, wars between civilized countries might be almost wholly avoided if more reliance were placed upon moral-force and less rein given to the impulse to employ physical force. This is a matter for the people in any state enjoying free institutions to take to heart. Let every man in a time of national difficulty ask himself this question: "Do I personally want to have blood shed over this matter?" Or this one: "Am I personally indifferent whether or not this dispute ends in bloodshed?" If a nation or the majority of a nation wants to have blood shed over a dispute with another nation, or is indifferent as to whether that shall be the outcome, the discussion will be carried on in a very different spirit from what it would be if there were a pronounced aversion to such a result. With nations, as with individuals, everything depends upon the spirit and ulterior purpose with which a question is approached. The cases must be very few in which a great nation, safe itself from attack, might not, in any matter in which minor interests are involved, resolve within itself that it will not resort to war—that it will work, and continue to work, on moral lines, trusting that, if it has right on its side, it will in due time carry its point. If blood cries from the ground against the slayer, what must be the responsibility of those who heedlessly and ruthlessly give their voices for war, when patience, moderation, and disinterestedness would have better accomplished every legitimate purpose? Slaughter is slaughter, murder is murder, however we may seek to weaken their import by a conventional treatment. War is mutual murder carried on professionally and systematically. Yet the primal command still makes its solemn appeal to the human heart and conscience: "Thou shalt not kill."

It is, unfortunately, only too easy to cultivate the military spirit in almost any nation, and the military spirit, it need hardly be said, is the spirit that seeks quarrels. To the military man war means excitement, emulation, reputation, promotion, subject of course to the possibility of injury or death. No one denies that deeds of heroism and self-devotion are done on the battlefield; but that men should acquit themselves nobly in the field is no compensation for the horrors of a war brought on by the predominance of the military spirit.

"'Great fame the Duke of Marlborough won,
And our good Prince Eugene.'—
'Oh, 'twas a very wicked thing,'
Said little Wilhelmine."

And every war is wicked and detestable that could consistently with national honor be avoided. When we say "honor" we do not mean "reputation." Reputation depends on the canons of judgment prevailing among those who presume to award it. In a dueling community a man's reputation might suffer by declining a challenge, but his honor would be intact if he declined from sincere unwillingness to do a wrong act. There is much honor sometimes in sacrificing reputation, particularly the "bubble reputation" that is won "in the cannon's mouth." Every appeal to the sword weakens the reliance placed upon principles of justice, and thus undoes a vast amount of the work of peace. When war is once set on foot, the national judgment is more or less blinded. True, it is the action of a majority of the people only—admitting that a majority wanted it—but who is uncompromising enough, when his country's armies are in the field, to proclaim that they are fighting in a wrong cause? A few may do it, but they do it at their peril. In all other matters a minority may censure with any degree of severity the policy of the majority, but not in the matter of a war once entered on. Yet how perverting such a situation is to right judgment, and how injurious an effect it must have on the rising generation, are only too apparent.

These reflections may not at first sight seem to have a very direct bearing on the interests for which this magazine is supposed to stand, but to our mind science, in the broad sense, has no function so important as that of settling the education of the young upon a right *moral* basis. No system of education deserves to be called scientific that does not place the idea of justice at the very foundation of human life. You can not do this, however, without making it a working principle, and without inculcating a belief in it as such. Applying the principle to national affairs, we see at once that a strong nation which desires to be just will take no advantage of its strength in its dealings with other nations. If it has a demand to make, it will make it simply in the name of justice, and cast no sidelong glances at its up-to-date battle ships or its well-equipped battalions. It will have unbounded patience with weaker communities, which, rightly or wrongly, may seem to think they have right on their side. It will not be ashamed to shrink from the shedding of blood. The "young barbarians" of our public schools are always only too ready to exalt might above right; but the judicious teacher into whom the true spirit of science has entered will seize every favorable opportunity for inculcating the great lesson that the moral law has a way of vindicating itself in the end, and that the inheritance of the earth has been promised not to the quarrelsome or the overweening, but to the meek. A generation brought up on these principles would be slow to make war, and

their influence on the world would be in every way powerful for good.

LANGUAGE AND LIFE.

THE ordinary school education in language and grammar is doubtless responsible for the impression which we find existing in so many minds that, in all matters of verbal expression, there is some one absolute standard of authority to which it implies simply ignorance not to bow—some supreme court, as it were, empowered to decide for us what words we are to use, how we are to pronounce them, and what rules of syntax we are to follow. It would be difficult, doubtless, to impart to children or very young people the wider and more scientific view of language, inasmuch as they need, in the first place, clear guidance as regards usage rather than correct theory. The idea, therefore, with which they grow up, if their school studies take any hold upon them at all and if no wider culture comes to change their way of looking at things, is that some very wise man made an infallible grammar and another very wise man an infallible dictionary, and that no one need be in doubt in regard to what is orthodox in language who has access to these tables of the law. We have known grown-up persons to turn away with a very skeptical air, and a kind of look as if they had found out a weak spot in your educational armor, when they were told that really it was impossible to say which of two pronunciations of a word was right and which was wrong—that either might be employed without mortal offense against elegance of speech or good breeding.

A hidebound view of language tends so much to narrow thought on general subjects that it seems to us of importance that the true and scientific view of the subject should be brought forward whenever opportunity offers. Mr. William Archer, the well-known English critic, contributed an article not long ago to the Pall Mall Magazine which might be read with much advantage by pedants and purists, and all blind followers of authority. He takes the broad ground that language is a transcript, as it were, of life, and that as life widens and becomes more varied, language must do the same. It must reflect the fancy, the imagination, and the humor of the day, and not merely the fancy, imagination, and humor of past generations. If we want a language that is fixed and unalterable in its forms we must seek one that has ceased to be spoken by men. Even then we can not always get absolute decisions. Cicero is perhaps the best standard of Latin prose, but no competent critic would say that his writing was flawless. We know that grammatical questions were much debated among the ancients, and we have no doubt that many such questions were left unsettled. In a living language there must be unsettled questions. There is a constant struggle for life going on among the words and phrases with which men endeavor to express their ideas, and, at a given moment, it is impossible to say which shall prosper, this or that. The word or phrase that prospers—that commends itself, after adequate trial, for expressiveness, convenience, or euphony, or for any combination of useful qualities—will survive and become classic; the expression that has nothing special to commend it, beyond its novelty and slanginess, will probably pass, after a brief and partial currency, into the vast limbo of the unfit. All we can say of a word at a given moment is how far it has actually become current and what kind of society it keeps. What its fortune will be we can only guess. Just as in the financial

world great fortunes are sometimes very suddenly made and names before obscure spring into world-wide notoriety, so, in the realm of language, a word of very uncertain ancestry and no social repute may assert its right to recognition and take its place among the best.

It does not follow from this that it can ever be a matter of indifference what words we use or what tricks we play with language, any more than it can be a matter of indifference what personal habits we adopt. Language is the clothing of our thoughts, and as such it may exhibit the same qualities which attach to the clothing of our bodies. It may be marked by neatness and propriety, or by slovenliness and want of taste. Some men are overdressed, and some affect over-fine language. Some go after the latest novelties in the tailoring world, and some after the latest slang, asserting thereby their resolution to be up to date. It is needless to draw the parallel further, but it is evident that there is wide scope in the choice of language for the exhibition of personal preference and personal character. We think it safe to say that the interests of a language, considered as an instrument of thought, will be best promoted by those who pay due respect to its established forms, and only countenance such neologisms as make good their claim to acceptance by supplying a real want. Mr. Archer, in the article we have referred to, states, and we do not doubt with truth, that the English language has been greatly enriched and strengthened by the fact that it has been spoken and written by millions of people on this side of the Atlantic, leading an intense and vigorous life of their own, under conditions very different in many respects from those prevailing in the mother country. The language moves with a freer step, beats with a stronger pulse, and assumes a more imperial bearing from the fact that it expresses the activity and sums up the life of the foremost communities of the human race in both hemispheres.

A great classical scholar not long ago wrote a letter to an English weekly newspaper expressing a very contemptuous estimate of the French language, as being only a degraded form of Latin. He thought it a great disgrace to the language that it had no better word for "much" than *beaucoup,* which, as he learnedly explained, came from two Latin words meaning "fine" and "blow." The most cursory examination of any language will show that it abounds in just such verbal devices. We do not in English put the words "great" and "stroke" together, but, using them separately, we say "a great stroke" of luck and of many other things when there is no question of "striking" at all. In the same way we would say "a great hit," when there is no question of hitting, except by remote analogy. Languages grow rich and flexible precisely by the adoption of such convenient combinations. What they may originally have meant becomes a matter of little moment when once they have become thoroughly accepted and thoroughly expressive. After they have become welded together, as sometimes happens, in one word, it is an advantage rather than otherwise if the separate meanings of their constituent parts become lost to all except the professional etymologist. As long as the separate parts retain their separate meaning some sense of incongruity will sometimes arise in connection with the use of the term. Thus to say "a handful of corn" is all right, but one might feel that it was not all right to say "a mere handful of men." Yet it would be futile to criticise the expression which has become idiomatic Eng-

lish. If the word "handful" had parted with its essential meaning as completely as say the word "troop" has, for all but etymologists, there would be no kind of incongruity in its employment for any small number or quantity whatsoever.

The scientific view of language, then, is that it represents the effort of mankind to use audible symbols for the expression of thought; that it follows the development of man's activity and enlarges with his enlarging knowledge, and comprehension of things; that while its object is essentially a practical one it gathers beauty with use and age, and begins to react on the minds of its makers; that its makers are the people, not the grammarians, these being merely its policemen, who, useful in general, are sometimes too officious; that great writers are the architects who felicitously arrange materials which the people have gathered and shaped, placing the best of such materials where they can be seen to best advantage; finally, that the language of each nation is its most precious possession, the record of its civilization, and the repository of all that is best in its moral and intellectual life, and that it is therefore the duty of all who make any pretensions to liberal training to watch over their heritage and, while allowing all reasonable scope for further development, to guard it by all means in their power against degradation and pollution. A great people will have a great language: when a language shows signs of weakness or declension, there is reason to fear for the civilization of which it is the expression.

Fragments of Science.

"Dark Lightning."—The attention of meteorologists and photographers has been engaged to a considerable extent, within a few months past, with the appearance on photographs of lightning of what seemed to be dark flashes as well as bright ones. In the effort to account satisfactorily for the phenomenon it has been referred to photographic reversal, due to extreme brilliancy; to a predominance of infra-red radiations; to the existence of flashes deficient in actinic rays; to changes in the density of the air occasioned by the spark, when a dark line with a light line within it is shown if the air is compressed, and a light line inclosing a dark one if it is rarefied; and to some qualities of the photographic plate. The first real light was thrown on the subject by some experiments described by Mr. A. W. Clayden, who, having photographed some electric sparks of different intensities, before developing the plates exposed them to the diffused light of a gas flame. The brilliant sparks then yielded images which might either be called normal with a reversed margin, or reversed with a normal core, while the fainter images were completely reversed—or, in other words, came out darker than the background. The "fogging" of the picture, to produce this reversal, must be done after the image of the flash is impressed; for if it is done before, the image appears lighter than the background. This effect, which is called the "Clayden effect," is accepted as a satisfactory explanation of the phenomenon by two of the authors who have most studied it—Dr. W. J. S. Lockyer and Prof. R. W. Wood, of the University of Wisconsin. Professor Wood, on repeating Mr. Clayden's experiment, obtained dark flashes without any difficulty, but as they failed to appear when the light of an incandescent lamp was substituted for the electric spark, he concludes that there is something in the spark essential to the reversal. Dr. Lockyer summarizes his conclusion by saying that dark-lightning flashes "do not exist in Nature, but

their appearances on photographs are due to some chemical action which takes place in the gelatin film."

"Warming Up."—"Warming up" is the expressive term of general currency, which Dr. E. G. Lancaster adopts to denote the process in which one starting on any work in a little while suffers a short period of fatigue, from which he soon recovers, to go on with new and increased vigor. This occurs in the course of walks, with students engaged in earnest reading or in writing, and in animals, as in dogs on the chase, the animals pursued, and racehorses. "It is said of two famous trotters, each of which has reduced the world's record within a few years, that the period of warming up was very characteristic. . . . Athletes, especially ball players, realize the importance of practice just before the games, to be followed by a slight rest. A pitcher would hardly enter the box till he had got his arm in working order by a few minutes' practice. Orators often are dull at first, but warm up. It is said that Wendell Phillips was often hissed for his slow, uninteresting speech, but rallied to the occasion at such times with his masterly oratory." Dr. Lancaster has experimented on the phenomena, using a method like those of Mosso and of Lombard in the psychological laboratory at Clark University, and publishes the results, with details and curves, in the papers of the Colorado College Scientific Society. He tried ten or twelve subjects, experimenting on the middle finger of the right hand, and gaining most of his results from four or five persons. He finds that warming up is general, but not universal. One subject always did his best work first. He likewise showed no warming up in his mental work. The phenomenon called "second mind" is closely allied to warming up, but is not the same. The author is of the opinion that the importance of this process is greatly misunderstood.

Sixty Years' Improvements in Steamships.—A review of what has been accomplished in sixty years in the improvement of transatlantic traffic, given by Sir William H. White in his address at the British Association on Steam Navigation at High Speeds, shows that speed has been increased from eight and a half to twenty-two and a half knots an hour, and the time of the voyage has been brought down to about thirty-eight per cent of what it was in 1838. Ships have been more than trebled in length, about doubled in breadth, and increased tenfold in displacement. The number of passengers carried by a steamship has been enlarged from about one hundred to nearly two thousand. The engine power has been made forty times as great. The ratio of horse power to the weight driven has been quadrupled. The rate of coal consumption per horse power per hour is now only about one third what it was in 1840. Had the old rate of coal consumption continued, instead of three thousand tons of coal, nine thousand would have been required for a voyage at twenty-two knots. Had the engines been proportionately as heavy as those in use sixty years ago, they would have weighed about fourteen thousand tons. In other words, machinery, boilers, and coal would have exceeded the total weight of the Campania as she floats today. "There could not be a more striking illustration than this of the close relation between improvements in marine engineering at high speed. Equally true is it that this development could not have been accomplished but for the use of improved materials and structural arrangements."

American Advances in Forestry.—The Department of Agriculture having determined to prepare a book for the Paris Exposition, reviewing what has been accomplished in scientific agriculture in the United States, the Division of Forestry will contribute to it a short history of forestry in the United States, with an account of the efforts of private landholders to apply the principles of forestry. Much more has been accomplished in the United States in the way of forestry than has been supposed. Mr. Pinchot, the forester of the division, holds that wherever private owners have made the effort to use the merchantable timber on their woodland without injuring its productive power, and to establish new forests, there has been the intention of true forestry. The methods may have been imperfect, but

they have tended toward economic forest management so far as their object was the continued use of the land for producing woods. Among the measures looking in this direction Mr. Pinchot mentions in his circular the practice which has been adopted "because it pays," in some of the spruce lands of the Northwest, of leaving the small trees standing, so that the lumbermen can return for a second crop earlier than would otherwise be possible; and the adoption by farmers of methods in getting their wood, for saving the best trees and promoting their growth and that of the new ones; of keeping sprout lands to be cut over regularly and systematically, for periodical renewal, and of tree planting on waste places, hillsides liable to be washed, and the banks of streams. Other forms of planting are the institution of wind breaks in the treeless West, and special plantations for fence posts, etc. A kind of forestry practice is likewise indicated in the special pains that are taken by farmers and in lumbering districts to lessen the danger of fires. Forester Pinchot desires that all the information that can be gained be communicated to him for the proposed article.

Professor Putnam on the Origins of the American Races.—In his address as retiring President of the American Association, Prof. F. W. Putnam, after expressing his high opinion of the late Dr. D. G. Brinton and his scientific labors, referred to the differences of opinion that had existed between them in respect to the origin of the American peoples, and proceeded to expound his own views on the subject. He regarded the term "mound-builders" as comprehensive enough to include all the peoples who had left the marks of their former presence in this country. Even the shell heaps could not be regarded as the work of one people. From the time of the earliest deposits—which were of great antiquity—to the present, such refuse piles had been made and many of the sites reoccupied, sometimes even by a different people. So with the mounds of earth and stone; many of them are of great antiquity, while others were made within the historic period, and even during the first half of the present century. These works were devoted to a variety of purposes, and there are many different kinds of them. Besides the mounds, there are groups of earthworks of a different order of structure, that must be considered by themselves — great embankments, fortifications, and singular structures on hills and plateaus that are in marked contrast to the ordinary conical mounds, and mounds in the form of animals and of man. The considerable antiquity of these older earthworks is proved by the accumulation of mold and the forest growth upon them. "If all mounds of shell, earth, or stone, fortifications on hills, or places of religious and ceremonial rites, are classed, irrespective of their structure, contents, or time of formation, as the work of one people, and that people is designated as the 'American Indian' or the 'American race,' and considered the only people ever inhabiting America north and south, we are simply . . . not giving fair consideration to differences, while overestimating resemblances." Citing analogies between our earthworks and Mexican structures, and looking upon the Pueblos as a connecting link, "we must regard the culture of the builders of the ancient earthworks as one and the same with that of ancient Mexico, although modified by environment. Our northern and eastern tribes came in contact with this people when they pushed their way southward and westward, and many of their arts and customs still linger among some of our Indian tribes. It is this absorption and admixture of the stocks that has in the course of thousands of years brought all our peoples into a certain uniformity. This does not, however, prove a unity of race.

Heat Insulators.—Mr. C. L. Norton has made experiments, at the request of Mr. Edward Atkinson, in order to determine the relative efficiency of several kinds of steam-pipe covering now on the market: to ascertain the fire risk attendant upon the use of certain methods and materials employed for insulation of steam pipes; to show the gain in economy attendant upon the increase of thickness of coverings; and to find the exact financial return that may be expected from a given outlay for covering steam pipes. A method of experimentation was adopted which repre-

sented as nearly as practicable the conditions existing in the actual use of steam pipes. Of sixteen non-conducting preparations tried, the most efficient were found to be those made of cork; next was a cover composed of an inner jacket of earthy material and an outer jacket of wool felt; and next magnesia. In reference to the last substance it is, however, observed that, while it is a most effective non-conductor, the name has been applied to many compounds of which the greater part consist of carbonate of lime or plaster of Paris, materials which are not good as heat retardents. Asbestos is merely a non-combustible material in which air may be entrapped, but, when non-porous, is a good conductor of heat. Generally speaking, a cover saves heat enough to pay for itself in a little less than a year at three hundred and ten ten-hour days, and in about four months at three hundred and sixty-five twenty-four-hour days. The decision as to the choice of cover must, however, come from other considerations, as well as from that of non-conductivity. Ability to withstand the action of heat for a prolonged period without being destroyed or rendered less efficient is of vital importance. The cork coverings were found to respond to this test extremely well, and there can be no question respecting magnesia; but Mr. Norton does not consider it safe to put upon a steam pipe wool, hair, felt, or woolen felt in any form, though the danger is not likely to accrue when an inch of fireproof material stands between the felt and the pipe. In general it may be said that if five years is the life of a cover, one inch is the most economical thickness, while a cover which has a life of ten years may to advantage be made two inches thick. The method of judging a pipe cover by the warmth felt on putting the hand upon it is fallacious; the sensation depends so much upon the nature of the surface that it utterly fails to give any idea of the actual temperature.

Effect of Sea Water on Soil.—In a paper read at the British Association, 1899, on the chemical effect of the salts of the salt-water flood of November 27, 1897, on the east coast of England, Messrs. T. S. Dymond and F. Hughes recorded the remarkable result that, although the proportion of salt left in the soil was insufficient to prove injurious to growing crops, the earthworms were entirely removed, with the consequence that very few crops were worth harvesting the following year. In the next year nine tenths of the salt at first present had disappeared from the soil, and young worms had again made their appearance, but still the condition of the soil remained unsatisfactory, the rate of percolation of water through the flooded earth being only one half as rapid as through the unflooded. The authors ascribe this to the action of the chlorides of the sea water on the silicates of the soil with the formation of silicate of alumina in a gelatinous condition.

The War against Monopolies.—Mr. Robert Ewen writes, in the Westminster Review, demanding free bank circulation as likely to be a very effective weapon to be used in "the coming contest with monopolists." The subject seems to have attracted official attention in England in 1875, when Sir Stafford Northcote was Chancellor of the Exchequer. As chairman of the committee appointed to inquire into the working of the Bank Acts, he submitted a memorandum showing that, while certain items of the monopoly enjoyed by the Bank of England had been withdrawn, a residuum of restrictions on issuing banks still remained unrepealed. Some other countries have found a way of giving elasticity to the currency by buying in and laying aside their bonds, as the United States has recently been doing. This can not be done in Great Britain, because the Bank of England and the other bank monopolists block the way. The bank is tied down by acts of Parliament to buy and sell gold at a fixed price, and this restriction has been a cause of panics, whereas had gold been allowed to rise and fall in price, according to supply and demand, and the bank got a free hand in dealing with that commodity and in issuing legal notes to supply the circulating medium, "all would have gone well." Foreign protectionists now have the power to prevent British goods from getting into their markets by imposing heavy duties on them, and at the same time forcing their produce into British markets, be-

cause English laws allow them to get gold from the English cheaper than their goods can be obtained. "Suppose a merchant in Britain buys £100,000 worth of corn from America and gives a check on the Bank of England for the amount of the purchase. The American draws the £100,000 in gold and takes it home; he will have to pay no export or import duty thereon—indeed, the probability is he may get a premium on the gold in America. But reverse the transaction: Suppose the British merchant sold £100,000 worth of his goods to America, there would, in the first place, be the exorbitant duty imposed there upon our manufactures of from forty to fifty per cent. Or suppose our merchant wished to buy corn or any American produce in exchange for his goods in place of bringing money, the case would be different—it would tell against the American farmer, who would get a less price for his corn, etc., than he would have done by free trade." This instance is given "to show how free trade in gold would bring about free trade and reciprocity between the United States and Britain, and is applicable to every other state with which we trade. . . . There should be full scope given to all good banks in the country, large or small, to carry on banking business in the best modern manner for the benefit of all parties, so as to encourage and develop all trades and industries."

Rats and the Plague.—In his introductory address at the opening of the London School of Tropical Medicine, Dr. Manson preached a war of extermination against rats with the vigor of Cato calling for the destruction of Carthage. "Were I asked," he said, "how I would protect a state from plague, I would certainly answer, Exterminate the rats as a first and most important measure." He added, "At the present juncture, were I the responsible sanitary head of any town in Europe, in anticipation of a possibility compared to which in horror and in destructiveness a general European war would be a trifle, I would do my best to have every rat and, if possible, every mouse in my district promptly exterminated." Dr. Manson does not reveal his plan of campaign. Wholesale poisoning of sewers might have serious disadvantages, and there would be difficulties about inveigling the rodent population of these subterranean health resorts (as some enthusiasts consider them to be) into a lethal chamber. Are we to cry havoc and let slip the *cats* of war? or to hurl an army of snakes against the foe? In either case we might find ourselves in the awkward position of a king who had called a too powerful auxiliary to his aid. Already action is being taken on the rat theory of plague. The French Government has ordered that special precautions are to be taken to prevent the importation of rats in vessels from plague-stricken places. It is to be hoped that similar precautions will be taken in regard to the transports which convey the Indian contingent to the Cape, or the situation there may become complicated by the intervention of an enemy who will deal destruction impartially to Boers and to Britons.

Forestry in California.—As a remedy for the devastation of the forest lands of California, Marsden Manson, having shown that Government administrations with politics in them can not be trusted in the matter, recommends that all forest reservations and public lands upon mountain slopes within the borders of the State be granted to the University of California in trust, for the purpose of maintaining, developing, and extending the water supply of those regions forever. For this purpose the regents should be empowered to lease, under proper control, the timber cutting and pasturage privileges of those areas, and to use the resultant fund to protect the catchment areas, to maintain a college of practical forestry, to construct reservoirs at such points as may be necessary to the industries of the State, and dispose of the water for the benefit of the trust, to acquire mountain lands to be added to the catchment areas, and to do all such things as may maintain wise systems of forest and water conservation and use. The extent of income-bearing property which can be made available for forest preservation and storage of flood waters, Mr. Manson says, is far beyond the general idea.

Another New Element.—The mineral pitchblende is distinguished for its

radio-activity, or the property it has of emitting the peculiar light-rays which have recently attracted attention. The property has been attributed to the presence of uranium, one of the most radio-active among the known metals. About a year ago the chemists M. and Madame Curie, examining the different substances in pitchblende, found among them two new radiant substances, both more active than uranium, which they called polonium and radium. Polonium was found to be closely akin to bismuth, accompanying that metal in all its reactions, but separable from it by fractionation. Radium resembles barium in its chemical reactions. Recently M. A. Debierne, examining one of the products of solution and precipitation of pitchblende, observed intensified radio-active properties in a portion containing titanium, and on further investigation found still another substance showing the principal analytical properties of titanium, but which emitted extremely active rays. While these rays were comparable with those observed from polonium and radium, the chemical properties are entirely different from those of these substances. Radium, however, is spontaneously luminous, while the new substance is not.

MINOR PARAGRAPHS.

Some recent experiments were made by Armand Gautier on the amount of the chlorides contained in sea air. They were conducted at the lighthouse at Rochedouvres, situated about fifty-five kilometres from the coast, during and after the long continuance of a good breeze directly inshore from the Atlantic. The air was drawn through a long tube containing glasswork, and this well then analyzed. He found that in a litre of air there was only 0.022 of a gramme of chloride of sodium. Small as this quantity is, it suffices, perhaps, with the aid of the traces of sodium present, to give sea air its tonic qualities.

The second International Congress on Hypnotism is to be held in Paris, August 12 to 16, 1900, Dr. Jules Voisin presiding. The programme of discussions includes such topics as the terminology of hypnotism, its relations to hysteria, its application to general therapeutics, the indications of it and suggestions for the treatment of mental disease and alcoholism, its application to general pedagogy and mental orthopædics, its value as a means of pathological investigation, its relation to the practice of medicine and to jurisprudence, and special responsibilities arising from the practice of experimental hypnotism.

The following is from a recent letter to Science by Prof. James H. Hyslop, of Columbia University: "So much has been published far and wide this last summer about my intention 'to scientifically demonstrate the immortality of the soul within a year,' that it is due to the facts bearing upon the choice between materialism and spiritism to say that I have never made any such professions as have been alleged. I wish the scientific public that still has the bad habit of reading and believing the newspapers to know that I was careful to deny that I made any such pretensions as were so generally attributed to me. More than one half the interviews alleged to have been held with me were the fabrications of reporters who never saw me, and the other half omitted what I did say and published what I did not say."

Some novel results have been obtained by M. Baillaud, of the Toulouse Observatory, France, from recent observations of the annular nebula in Lyra and comparisons with photographs taken in 1890. Among them are the discovery of small stars in the central space of the ring, the existence of bright points on the ring itself, a more distinct figure of the central star on the later photographs, giving it the aspect of a true star, and greater brightness in the central space, and certain changes in the shape of the edge of the ring, which shows at one point, more distinctly than in 1890, an eminence indicating a jet of matter escaping from the ring. Other nebulæ, especially that called the Dumb-bell and the nebula in the Crown, are spoken of as exhibiting similar phenomena.

The Chicago Manual-Training School, which is said to be the first independent

manual-training school in the United States, is now in its sixteenth year, having been founded in 1883 by the Commercial Club of Chicago. It has been, since 1897, an integral part of the University of Chicago. While its peculiar feature is manual training, it also furnishes instruction in the essential studies of a high-school course. The shop work and drawing are eminently practical. The making of a machine, such as a lathe or steam engine, is begun by the pupils in the drawing room, and is followed by them through the pattern-making shop, the foundry, and the forge room, and is perfected in the machine shop. The forge tools and engine-lathe tools are made by pupils. The courses of the school include a business course, a technological course, and a college preparatory course.

NOTES.

THE Massachusetts Institute of Technology has received, by the will of Mr. Edward Austin, deceased at the age of ninety-four years, a bequest of $400,000, the interest of which is to be used for the assistance of needy and meritorious teachers in prosecuting their studies. In addition to this bequest, the institute received, during 1898, an accession of $928,000 to its general funds, and one of $46,000 to its scholarship funds.

AT the recent meeting of the Allied Scientific Societies, at New Haven, Conn., Mr. G. K. Gilbert, of the United States Geological Survey, was chosen to act as retiring President of the American Association for the Advancement of Science, in place of Prof. Edward Orton, deceased.

THE meeting of the Allied Scientific Societies of the United States was held in New Haven, Conn., during holiday week. It was much larger than either of the meetings previously held, and was attended by nearly five hundred members, representing ten societies—viz., the American Society of Naturalists, the Association of American Anatomists, the American Morphological, Physiological, Psychological, and Chemical Societies, the Society for Plant Morphology and Physiology, the American Association for the Advancement of Science, and the Archæological Association of America. The discussions were all interesting.

THE great Roman Catholic Missionary Society, the Sacred Congregation of the Propagation of the Faith, is reported to have sent a circular to all its missionaries urging them to interest themselves in the collection of natural-history specimens for scientific societies and institutions. This is intended, it is said, to interest and encourage missionaries who have a scientific bent, and to inform the world that the Church is not hostile to biological research.

WE have to record, among the later deaths of men in science, the names of Francis Guthrie, formerly Professor of Mathematics in Graaff Reinet College and afterward in South African College till 1898, aged sixty-eight years; he was interested in botany, on which he gave public lectures, and, with Harry Bolus, revised the order of Heaths for *Flora capensis;* Prof. P. Knuth, botanist and author of researches on the relations of insects and flowers and on cross-fertilization, at Kiel, Germany, aged forty-five years; he had published two of the projected three volumes of the *Handbuch der Blüten Biologie;* Prof. R. Yatube, Japanese botanist; Ferdinand Tiemann, honorary Professor of Chemistry in the University of Berlin; Alexander McDougall, inventor, sixty years ago, of an atmospheric railway, and since of many useful mechanical and chemical appliances, at Southport, England; Dr. Camera Pestana, chief of the Bacteriological Institute at Lisbon, Portugal, of plague, which he contracted while experimenting with it at Oporto; and Prof. Elliott Coues, an American naturalist, most distinguished in ornithology, in Johns Hopkins Hospital, Baltimore, December 25th, after a surgical operation, aged sixty-seven years; he had been a professor in Norwich University, Vermont, and in the National Medical College in Washington, and had done scientific work while in the military service of the Government, in the Geological Survey, and in the United States Northern Boundary Commission; and was the author of several books on ornithology and on the Fur-bearing Animals, besides editing the journals of Lewis and Clark and other books of American exploration.

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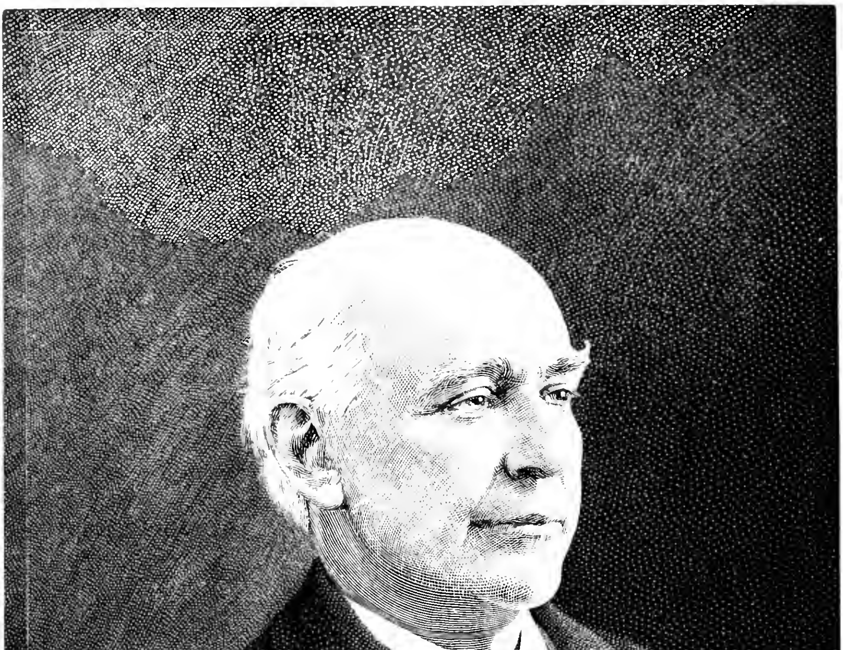

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THE TRANSPLANTATION OF A RACE.

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THE experiments which have been intentionally or accidentally made in transplanting organic species from the countries in which they have been developed to others of diverse soil, climate, and inhabitants are always of much interest to the naturalist—each of them affords indications of some value as to the relations of species to what we term "environment." In almost all instances we find that the transplanted forms undergo changes in consequence of the alteration of their circumstances. It is true that certain of our domesticated animals, such as the horse, the dog, and most cattle, follow men from the Arctic to the Antarctic Circle, and that sundry insect pests appear to demand nothing of Nature save the presence of man; yet, as a whole, the creatures we have turned to use, both plant and animal alike, have shown themselves incapable of accommodating themselves to conditions of temperature differing much from those in which they were developed. With hardly an exception, species or varieties which have been developed in the tropics perish when called on to withstand the winter of higher latitudes. Few, indeed, do well when taken to stations where the heat or the humidity differs greatly from that to which they are accustomed.

The intolerance of organisms to climatal changes is nowhere more evident than in the varieties, or species, as we would term them, of mankind. It is a well-attested fact that none of the tropical races has ever of its own instance colonized in the temperate zones. It is also clear that none of the northern peoples

have ever become fully acclimated within the tropical realm. The colonies which have been founded there by the Teutonic folk, including the English group therein, have been lamentable failures, the pure-blooded strains dying out in a few generations. The people of southern Europe have been a little more successful in the equatorial regions, probably because their blood has there to a great extent become mingled with that of tropical origin. These general conclusions concerning the climatal limitations of man would be unassailable were it not for the history of the negro in North America. In his case we have the one masterful exception to the rule, otherwise good, that creatures bred near the equator can not endure boreal conditions.

The negroes who came to North America had to undergo as complete a transition as ever fell to the lot of man, without the least chance to undergo an acclimatizing process. They were brought from the hottest part of the earth to the region where the winter's cold is of almost arctic severity—from an exceedingly humid to a very dry air. They came to service under alien taskmasters, strange to them in speech and in purpose. They had to betake themselves to unaccustomed food and to clothing such as they had never worn before. Rarely could one of the creatures find about him a familiar face of friend, parent, or child, or an object that recalled his past life to him. It was an appalling change. Only those who know how the negro cleaves to all the dear, familiar things of life, how fond he is of warmth and friendliness, can conceive the physical and mental shock that this introduction to new conditions meant to them. To people of our own race it could have meant death. But these wonderful folk appear to have withstood the trials of their deportation in a marvelous way. They showed no peculiar liability to disease. Their longevity or period of usefulness was not diminished, or their fecundity obviously impaired. So far as I have been able to learn, nostalgia was not a source of mortality, as it would have been with any Aryan population. The price they brought in the market and the satisfaction of their purchasers with their qualities shows that they were from the first almost ideal laborers. If we compare the Algonkin Indian, in appearance a sturdy fellow, with these negroes, we see of what stuff the blacks are made. A touch of housework and of honest toil took the breath of the aborigines away, but these tropical exotics fell to their tasks and trials far better than the men of our own kind could have done.

At their first coming, or soon afterward, the negroes were distributed along the coast of our country from the Carolinas to Nova Scotia. So far as I have been able to find, there appears to have

been no distinct difference in their tolerance of the climate in any part of this varied district. There are still negroes in the maritime provinces who are said to be the descendants of those who came upon the ground certainly more than a century ago. They are good specimens of their stock. So, too, along the New England coast and in New York there is a sufficient number of the progeny of those once held as slaves to make it clear that the failure to become a considerable part of the population in that district is not due to any incapacity to withstand the climate. The failure of the negro to increase in this field can be accounted for in other ways—by the effects of race prejudice, nowhere stronger than in this part of the country, and by the vice and misery that overtake a despised lower class.

It early became evident that slavery was to be of no permanent economic advantage to any part of the colonies within the glaciated district, say from central New Jersey northward. In that portion of the coastal belt the state of the surface and the character of the crops alike tended to make the ownership of slaves unprofitable. The farms were necessarily small. They became in a natural way establishments worked by the head of the house, with the help of his children. Such other help as was needed was, in the course of two generations, readily had from hired white men and women. It was otherwise in the tobacco-planting region to the southward. The cultivation of that plant, to meet the extraordinary demands that Europe made for it, gave slavery its chance to become established in this country. But for that industry the institution would most likely have taken but slight root, and the territory as far south as North Carolina would have been in social order not very different from Pennsylvania, New York, and the New England settlements. But, owing to some peculiar, as yet unrecognized, adjustments of climate and soil, tobacco for pipes has a quality when grown in the Virginia district such as it has nowhere else in the world, and the world turned to smoking it with a disregard for expense that made each laborer in the field worth some hundred dollars a year. Moreover, the production of good tobacco requires much care, which extends over about a year from the time the seed is planted. Some parts of the work demand a measure of judgment such as intelligent negroes readily acquire. They are indeed better fitted for the task than white men, for they are commonly more interested in their tasks than whites of the laboring class. The result was that before the period of the Revolution slavery was firmly established in the tobacco-planting colonies of Maryland, Virginia, and North Carolina. It was already the foundation of their only considerable industry.

Although the production of tobacco had made slavery a great economical success in the limited field where the best product was to be had, it is doubtful if the institution would have attained to any widespread importance but for the development of another form of planting—that of cotton. Thus, in Kentucky, where the crops, with the exception of a coarse tobacco, are the same as in the other Northern States of the Union, the institution, despite the long-continued scarcity of labor, never attained any very great development. The slaves were generally used for household service, but to no great extent in the fields, and in such employment only in the districts where the soil was of such great fertility that large quantities of grain were raised for export. In one third of that Commonwealth negroes were, and remain to this day, quite unknown. The invention of the cotton gin ended all hope that slavery might be limited to a part of the seacoast region, for nearly all of the lowland regions of the South, as well as some of the upland country north to the southern border of Kentucky and Virginia, are admirably suited to that crop—producing, indeed, a better "staple" than that of any other country. This industry, even more than that of raising tobacco, called for abundant labor which could be absolutely commanded and severely tasked in the season of extreme heats. For this work the negro proved to be the only fit man, for while the whites can do this work they prefer other employment. Thus it came about that the power of slavery in this country became rooted in its soil. The facts show that, based on an ample foundation of experience, the judgment of the Southern people was to the effect that this creature of the tropics was a better laborer in their fields than the men of their own race. Much has been said about the dislike of the white man for work in association with negroes. The failure of the whites to have a larger share in the agriculture of the South has been attributed to this cause. This seems to me clearly an error. The dislike to the association of races in labor is, in the slaveholding States, less than in the North. There can be no question that if the Southern folk could have made white laborers profitable they would have preferred to employ them, for the reason that the plantations would have required less fixed capital for their operation. The fact was and is that the negro is there a better laboring man in the field than the white. Under the conditions he is more enduring, more contented, and more trustworthy than the men of our own race.

The large development of the cotton industry in this country came after the importation of negroes from Africa had ceased to be as completely unrestricted as it was at first. The prohibition of the traffic came indeed before the needs of laborers in the more

Southern and Western slave States had been met. For a while there was some surreptitious importation, which in a small way continued down to the middle of this century, but this smuggling was quite insufficient to supply the market of the new States with slaves. The result was that the border slaveholding States became to a considerable extent the breeding grounds for men and women who were to be at maturity exported to the great plantations of Alabama and Mississippi, there to be herded by overseers in gangs of hundreds, with no hope of ever returning to their kindred. With this interdiction of the foreign slave trade the evils of the former situation became magnified into horrors. The folk who were brought from Africa came from a state of savagery to one of relative comfort. When once adjusted to their new conditions, their lot was on the whole greatly bettered. But their descendants, who had become attached to the places where they were born with the peculiar affection the better of them had for their homes, being accustomed to masters who on the whole were gentle, were now to undergo a worse deportation than that which made them slaves. It is not too much to say that the deeper evils of the system to the slaves themselves, as well as to their masters, began with this miserable slave trade that went on within the limits of this country, and was about at its height when the civil war began.

It can not be denied that even in the best stages of slaveholding there had been a good deal of commerce in slaves where the feelings of these chattels were in no wise regarded. Still, there was a prevailing sentiment among all the slaveholders of the gentler sort that it was in a way disgraceful to part families. I distinctly recall, when I was a lad, some years before the civil war, my maternal grandfather often charged me to remember that I came of a people who had never bought or sold a slave except to keep families together. I know that this was a common feeling among the better men of Kentucky and Virginia, and that the practice of rearing negroes for the Southern market filled them with sorrow and indignation. Yet the change was the inevitable result of the system and of the advancing commercialism which separated the plantation life more and more from that of the owner's household. At the time when the civil war began the institution of slavery was, from the commercial point of view, eminently successful. Notwithstanding the occasional appearance of the spendthrift slave owner in Northern pleasure resorts or in Europe, the great plantations were generally in charge of able business men, who won a large interest on their investments and who were developing the system of planting in a way which, though

it appeared to those who were accustomed to close tillage as shiftless, was really well adjusted to the conditions. Not one fourth of the land of the Southern States that was well fitted for the work of slaves had been brought into use. The blacks who were carefully managed in all that regarded their health and in their morals, so far as might affect their breeding, were in admirable physical condition, and rapidly increasing in numbers. It is doubtful if ever a peasant class was so well cared for or so freed from avoidable diseases. The growing protest against the institution, so far as it operated in the South, was practically limited to the border States, mainly to Kentucky, where alone did a considerable number of well-born men set themselves against it. There is good reason to believe that if the civil war had not occurred the end of the nineteenth century would have seen a negro population in the South much more numerous than we now have there. Experience has shown that the American cotton crop is little affected by foreign competition, so that it would have maintained the success of the institution.

Although the system of slavery was by a chance of Nature so firmly planted on the cotton fields as to give it entire dominance in the South, and something like control of the Federal Union, there was one geographic condition that menaced its future, and in the end did much to insure its downfall in the events of the civil war, and most likely would have brought about its end even if the Confederacy had been established. This was the form and extent of the Appalachian uplands between the Potomac and the Ohio on the north and Alabama and Georgia in the South. In this area of nearly one hundred and fifty thousand square miles in extent the surface lies at an average height of some fifteen hundred feet above the sea; the good arable land is found mostly in narrow valleys suited only for household farms, totally unfit for the systematic agriculture in which alone negroes could be profitably employed as slaves. Into this area drifted the class of small farmers who by one chance and another had never been able to enter or to maintain themselves in the aristocratic class of slaveholders. These mountaineers—they may better be termed the hill people of the South—were an eminently peculiar people. They are not to be compared with the "poor white trash"—i. e., the downfallen and dependent whites, who were broken men in spirit, scarce above the slaves in quality. These poor whites were often, if not generally, either the weaker strains of the militant families or the descendants of the people who had been imported into this country by the land companies or sent out as peons.

Partly because of their separation from the slaveholding class

and partly because of the circumstances of their origin, the people of the Southern highlands formed a curiously separated class. They retained the quality of their English stock, as they had brought it with them—an independence, a carelessness as to life, and a humor for quarreling with those who were set above them whenever their liberties or their license seemed to be threatened. Even their customs and utensils held with curious adhesion to the usages of earlier centuries. Thus, in 1878, I found, in a secluded valley of southwestern Virginia, men hunting squirrels and rabbits with the old English short bow. These were not the contrivances of boys or of to-day, but were made and strung and the arrows hefted in the ancient manner. The men, one of them old, were admirably skilled in their use; they assured me that, like their fathers before them, they had ever used the bow and arrow for small game, reserving the costly ammunition of the rifle for deer and bear. These hill folk were, in a passive but obdurate manner, opposed to slavery, and even more to negroes. There are still many counties in this district where a negro has never dwelt. In some parts of it I have had people gather from twenty miles away to stare at my black camp servants, as the folk of central Africa are said to do at a white man.

At the outbreak of the civil war the Appalachian upland was still thinly peopled; it was, however, fitted to maintain a population of some millions. If the Confederacy had won its independence, its plantation districts, with a relatively small voting population, would soon have had to settle an account with the people of the hills. As it was, the existence of this folk in a great ridge of country extending from the Northern States to within two hundred miles of the Gulf of Mexico was an element of weakness which went far to give success to the Federal arms. It kept Kentucky from seceding, prevented the region of West Virginia from being of any value to the rebellion, and weakened its control in several other States. In all, somewhere near one hundred thousand recruits came to the Federal army from this part of the South. It is not improbable that to this folk we may attribute the failure of the great revolt. That they turned thus against the people of their own States to cast in their lot with those who were strangers to them shows their feelings toward the institution of slavery; it indicated where they would have stood if the Confederacy had been established.

It is not easy to picture the condition of the negro population in 1860. There is a common notion that it was consciously and bitterly suffering from its subjugation—ready to rise in arms against its oppressors. This view was indeed shared by the South-

ern people, who lived in chronic fear of insurrections. The error of it arose from the fallacious notion that the people of another race must feel and act as we would under like circumstances. The facts showed that the negro mind does not work in the fashion of our own. He had, it is true, suffered from slavery, but not as men of our race would have suffered. Against its deprivations and such direct cruelty as he experienced, not often great, he could set the simple comforts and small pleasures which are so much to him. That he was on the whole fairly contented with his lot, that his relations with his masters were on the whole friendly, is shown by his remarkable conduct during and since the civil war. If the accepted account of the negro had been true, if he had been for generations groaning in servitude while he passionately longed for liberty, the South should have flamed in insurrection at the first touch of war. We should have seen a repetition of the horrors of many a servile insurrection. It is a most notable fact that, during the four years of the great contention, when the blacks had every opportunity to rise, there was no real mark of a disposition to turn upon their masters. On thousands of Southern farms the fighting men left their women and children in the keeping of their slaves, while they went forth for a cause whose success meant that those slaves could never be free.

That the negroes desired to be free is plain enough. The fact that they fled in such numbers to our camps shows this. Their failure to revolt must be taken as an indication that their relations with their masters measured on their own instinctive standards were on the whole affectionate. They had the strength to have made an end of the war at a stroke. They were brave enough for such action. That they did not take it after the manner of their kindred of Santo Domingo is the best possible testimony as to the generally sympathetic relation which existed between master and slaves. Of this no better test can be imagined than that which the final stages of the institution afforded.

In taking account of the history of the slave in this Union it is not amiss for me to bear testimony as to the spirit with which the body of our slave owners met the singular obligations of their positions. There were here and there base men who abused their trust as masters—some, indeed, who never perceived its existence. But of the very many slave owners whom I can remember I can recall but three who failed to recognize the burden that fate had put upon them and to deal with it much as they dealt with the other cares of their households—conscientiously and mercifully, though often in the rude whacking way in which parents of old dealt with their children; so far as slavery was a household affair,

and even where the farm employed no more hands than could be gathered in a house "quarter," the people were commonly subject to an anxious scrutiny as regarded their moral and religious training. Here and there, especially when there were young white men about, the result was the deplorable mixture of the races. There is no question but that this was extensive, though the amount of it is exaggerated. Yet it was common enough to degrade the whites and to make of itself a sufficient reason for ending the institution, however profitable it might otherwise have been. Men of no race are safely to be trusted with such power. The social evil was the heaviest part of the load which the high-minded slave owners had to bear. It was shared in even larger measure by his wife and daughters. How heavy the cross was can only be known to those who remember the conditions of that unhappy time.

The result of the hopeless effort to keep the slaves in decent ways and to prevent the pollution of their sons was to make nearly every right-minded slaveholder at heart an abolitionist. Although the men, and even the women, who suffered most would have been disposed to slay any one who suggested that they shared the opinions of the detested antislavery folk, nearly every one in his heart reprobated the institution and in his mind was revolving some scheme, generally fanciful, by which an end of it might be made. They were in the unhappy position where overwhelming self-interest fought with their moral sense. Now and then some one of them passed the critical point and entered into the fold of the accursed abolitionists; but others, after the manner of average men, paltered with the situation, waiting for fate to decide the matter. In the meantime, they strove as best they could to lift these people to a higher estate.

In many ways the standard of care by which the conduct of a master in relation to his slaves was judged was high. He was expected to clothe them in a fit manner, keep them from the nocturnal wanderings, termed "running," so common a trait in these children of the tropics, to see that they were decently married, that they went to church in a dutiful way, and, above all, that they were not abused by other whites, particularly by other slaveholders. To strike or even to vilify the slaves of another was a very serious thing. The offended person knew well that it was his part to make his complaint to the servant's master. Where the negroes exceeded in number those needed for household and personal service—there were often a dozen or two thus employed in families of no great wealth—there was a division between the house people and the "hands." Those in the former group were selected folk, often belonging to families that had been associated with those of

their masters for a century or more. Such servants had rights that none could dispute. Not uncommonly their elders were the actual rulers of the establishment. These family slaves often received some little schooling, even when the laws forbade that slaves should be taught to read and write. The children of the household servants were allowed freely to play with those of their masters until the young people were about twelve years old. The boys of both often had their rough-and-tumble games together until they were young men. The field laborers, where the class was separate, had less perfect connection with their masters. They usually came to the family storeroom for the daily issued rations, which they received from the hands of the mistress or the daughter of the house. They were visited when sick, and their complaints were heard. They were free to all of the many festivities of the holiday time.

It is impossible to conceive of a more effective schooling for the African people than was given this adoption into the households, and often into the hearts, of high-minded masters. A like opportunity never before came and will never again come to so lowly a folk. The effect of this educative contact with the superior race is, as before noted, to be seen in the temper of the negroes during and after the civil war. Upon the high-minded master the effect of the institution was in many ways enlarging. A man is morally what his cares have made him, and of these the dutiful slaveholder has more than an average share. He grew in the power of command and in the habit of doing justice to many fellow-beings. He lived a large life. The qualities bred of his station have been of profit to his folk and time. All this is true of slavery of the domestic sort. It is not so in like manner of the great plantations which came with the development of the cotton and sugar industries. It was characteristic of the northern part of the South until it began to be the place of supply for the rapidly developing plantation district.

So long as the negro could look forward to life in the place and with the people of his birth his simple, careless nature opened to him little to bring a sense of danger. He was to live on until he passed in to the Elysium of the hereafter, of which he had no doubt whatever. Gradually there came, in the overcrowding of the farms and the diminishing fertility of the wasted land, the need of reducing the number of slaves. Then each year came the dreaded visits of the "trader," who was like a visible angel of death, to lead one or more into the far unknown country. Before the plantation demand for slaves began there were, of course, sales of slaves, but they commonly went as families, and not to places to them inconceivably remote. These could hope for Christmas

reunions and other exchanges, but when the negro was "sold South" the place and people that had known him would know him no more. My first impression of the iniquity of slavery came from the anxious questions of negroes as to the danger of their being sold to Alabama, that State being then the supposed destination of all those who were out of favor. They naturally strove to make interest with children whom they thought could successfully intercede for them.

There were several very diverse consequences arising from the exportation of slaves from the border States to the far South. It shook the confidence of the negro as to his safety in all that was dearest to him, and thus did much to degrade the relation between him and his master. It served, cruel as it was, to elevate the relatively uncivilized blacks of the more Southern districts, where the newly imported laborers were mostly accumulated. It curiously operated to elevate the quality of the blacks in what was termed the slave-breeding States, those where the institution had longest been established. This was due to the selection of those of lower grade for the market. As it became necessary to part with slaves, a choice was naturally made of men and women who had least endeared themselves to the household. Save in rare cases, the trader sought rather the lusty youths for their brawn than the more delicate, refined house people. Moreover, where a fellow had shown a tendency to any vice, the choice fell on him. In this way for two or three generations a weeding process went on, with the result that the negroes who were left in the districts where the work was done acquired a quality noticeably better than those on the Southern plantations. The difference is almost that we would look for between two distinct races. The faces of the selected folk are more intelligent, the lines of their bodies finer, their moral and intellectual quality very much above those of their lower kindred. They are at their best, in very numerous instances, as gentle as the elect of our own race.

Where, as in the Southern plantations, the institution of slavery was deliberately made the basis of large commercial interests, the motives were wholly different from whatever existed in the early and better days, when the slaves were appendages of a household. Even on the largest tobacco plantations the numbers were not such as to exclude a share of contact with friendly whites. But on the great properties of the South the negro was not to any extent subject to the influences which had in the earlier stage of his apprenticeship done so much for him. Worked in gangs that were counted by the hundreds, seeing no whites except the overseers, they tended to lose what little culture they had gained.

Their peculiar but perfectly intelligible speech began a degradation into a puzzling jargon. African superstitions, little if any trace of which remained among their kindred in Virginia and Kentucky, regained their hold. Marriage and a respect therefor, which had been tolerably well affirmed, tended to disappear. All trace of good thus vanished from the system.

Although the great plantation, of the Mississippi type, was a relatively novel feature in American slaveholding, it was evidently the only largely profitable method of using slave labor. In the household system the care of the children, the aged, and the infirm, the unbusinesslike management of the labor, and the tendency to slipshod methods which with negroes can only be corrected by strict discipline, made ordinary farming unremunerative. It is evident that the profit, other than that in mere money, which the institution in the earlier state had brought to master and slave was rapidly diminishing, and that any further maintenance of it would have been calamitous. Though we may regret that it was ended by the civil war, it is difficult to see any other way in which it could have been terminated, or any profit which could have been gained by postponing the crisis.

MODERN CITY ROADWAYS.

By NELSON P. LEWIS.
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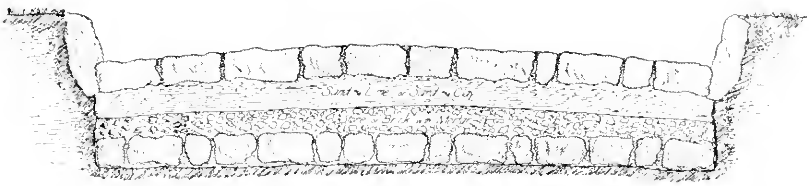
ONE of the conspicuous results of cheapened transportation and the facility with which the products of field, forest, mine, and factory can be transferred to the consumer has been the rapid increase in population of all our cities. In 1890 over forty-five per cent of the population of New York State (nearly six millions) was concentrated in four cities, while it is estimated that the greater city of New York contains at present not less and probably more than fifty per cent of the State's population. Nor is this tendency characteristic only of American cities, though the general impression seems to be that it is more conspicuous with us. In fact, many European cities (notably those of Germany) have outstripped ours in growth. In 1870 Berlin had about 150,000 less people than New York; in 1890 it had over 73,000 more. In 1875 Hamburg exceeded Boston in population by but 6,000, while in 1890 the German city was more than 121,000 ahead.

Meanwhile the rural population the world over has increased very slowly, or has positively decreased. The massing together of large numbers of people, without proper regard to sanitary con-

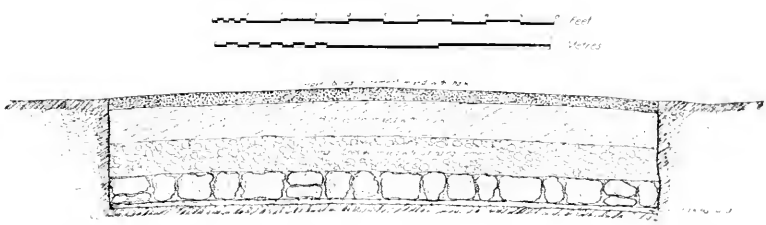
ditions, has always resulted in great mortality, as witness the terrible plagues which have swept over the old cities of Europe, and the disastrous results during the summer of 1898 of concentrating large numbers of our volunteers in camps not subjected to rigid sanitary regulations.

It has been amply demonstrated, however, that our cities can be made at least as healthful as the country districts, and an increasingly large number of engineers are engaged in such city building.

One branch of this municipal work will be considered in this paper—that of street improvement. The first impression gained by a stranger entering a city is undoubtedly that produced by the appearance of its streets. If they are poorly paved, irregular,



SECTIONS OF ROMAN ROADS



dirty, and generally unkempt, he will consult his time table to see how soon he can get away. If they are broad, smooth, clean, well shaded and lighted, he will stay as long as possible.

In spite of the pride of the American people in the development of our cities, and notwithstanding the fact that their wealth enables them to have only the best, they have been slow to appreciate the value of thoroughly well-paved streets. As stated by Mr. Albert Shaw, European cities have been ahead of us in accepting the doctrine that "smooth and clean highways are a wise investment from every point of view, and that so long as the work is done in a thorough and scientific manner the result is worth having, regardless of cost. No city should think itself rich enough to prosper without them, and no city is so poor that it can not afford them if it has any reason whatever for continued existence.

Good roadways are cheap at any cost, and bad ones are so disastrously expensive that only a very rich country, like the United States, can afford them."

Space will not permit even a brief history of street paving, or an attempt to sketch its development, but reference will be made to the different kinds in general use, and the kind most in favor in various cities. Probably no one has introduced the subject of pavements without reference to the Roman roads.


A Street in Pompeii, showing Old Roman Pavement.

While Carthage was probably the first city to boast of paved streets, the Romans soon followed its example, and all over Europe, Asia, and Africa, as far as the domain of their emperors extended, they built with the greatest care and at enormous expense that magnificent system of roads which were often supposed, in the middle ages, to be of supernatural origin, and remain the wonder of our modern civilization. These roads were generally from four to six metres in width, and were constructed in this way: The roadbed was excavated; in it was placed a layer of stones, which were sometimes united with mortar. These stones were such as were most available, sometimes rounded stones similar to the cobblestones with which we are familiar, and in some cases in the Alps the foundation was a compact mass of angular stones, two feet or more in their longest dimension, carefully fitted together.

On this foundation was placed a layer of plaster made of stone or brick pounded with mortar; then a course of sand and lime or sand and clay, leveled and pounded until very hard. The top or wearing surface was made of irregular flat stones, fitted together with nicety and united with cement. The total depth of these roads, or pavements, as they can properly be called, was from three to (in some cases) seven feet. It is said that in the province of Hispania alone (Spain and Portugal) twenty thousand miles of roads were built.

The first stone pavements to be laid in modern city streets were

those formed of stones in their natural condition, variously known as bowlders, pebbles, or cobblestones.

The first attempt at a street pavement in this country was doubtless that referred to by Mrs. John King Van Rensselaer, in the *Goede Vrouw of Mana-na-ta*, where she says, in speaking of what was once called Brower Street, because it passed by the great brewery built by one of the first of the Van Cortlandts: "This street lies between Whitehall and Broad, and was one of the first lanes laid out by the settlers, and was commonly known as 'The Road.' In 1657 it was paved with small round cobblestones, and the circumstance created such a sensation that the country people visited it as a curiosity, and it was one of the sights of the little dorp. The burghers laughingly nicknamed it Stone Street, which name it still retains. The improvement was effected by Madame Van Cortlandt, as she could not endure the dust that filled her tidy house, caused by the heavy brewers' wains that were constantly passing her door."

This cobblestone pavement, laid on Stone Street nearly two centuries and a half ago, has been a persistent type, and, on account of their availability and cheapness, such stones continued to be used in many cities until within a very few years. When they were well shaped and uniform in size they made quite a durable pavement, and, though rough and noisy, were capable, when well laid, of sustaining a considerable traffic. Fortunately, the better class of these stones are now so scarce and the poorer ones are so execrable that this type of pavement is becoming obsolete, though there are many miles for which more civilized pavements are yet to be substituted, two hundred and thirty-eight miles of which are unfortunately in the Borough of Brooklyn. The next step in advance was the use of stone shaped to uniform size, or approximately so, and with a more or less smooth surface. This is the pavement in most general use to-day, and for

A Street in Naples, showing Large Paving Stones.

permanency and, consequently, cheapness can not be surpassed. When first used, these blocks were quite large, and the size has been decreased until the best stone pavements laid at the present

Cobblestone Pavement on Saratoga Avenue, Brooklyn.

time in Great Britain are six-inch cubes, or still smaller, with a surface four inches square and a depth of seven inches.

But stone pavement when most carefully laid and maintained is noisy and unpleasant to ride over, and in these days we can never reconcile such a pavement with a handsome residence street. The writer experienced a distinct shock when on riding over Euclid Avenue, in Cleveland, last year, he found it still paved with Medina sandstone blocks, and it seemed that this famous street was still living on the reputation which Bayard Taylor gave it years ago as the handsomest street in the world.

In looking about for something more quiet and smooth than stone, the first material tried was wood. In London the first wood pavement was laid in the Old Bailey in 1839, and was soon followed by many others. None of these pavements lasted more than seven years, and, as they cost more than granite and were so short-lived, a prejudice arose against them, and as they wore out they were mostly replaced with granite. Since that time wood pavement has become popular again, and a large area is now covered with it. The material most generally in use is Baltic fir, though there is quite a large amount of Australian hard wood which is more durable. The people of London seem willing to bear the greater ex-

pense and submit to the annoyance of more frequent renewals for the sake of the quiet, and wood is certainly the least noisy of all known pavements.

Paris had at the close of 1893 more wood than asphalt, the areas of pavements of different kinds being as follows:

Stone	7,541,258 sq. yds.,	71.5 per cent.
Wood	886,236 "	8.4 "
Asphalt	402,394 "	3.8 "
Gravel or macadam	1,724,632 "	16.3 "

Berlin also has some wood pavements, but asphalt seems more popular, though by far the greatest area is still of stone pavements.

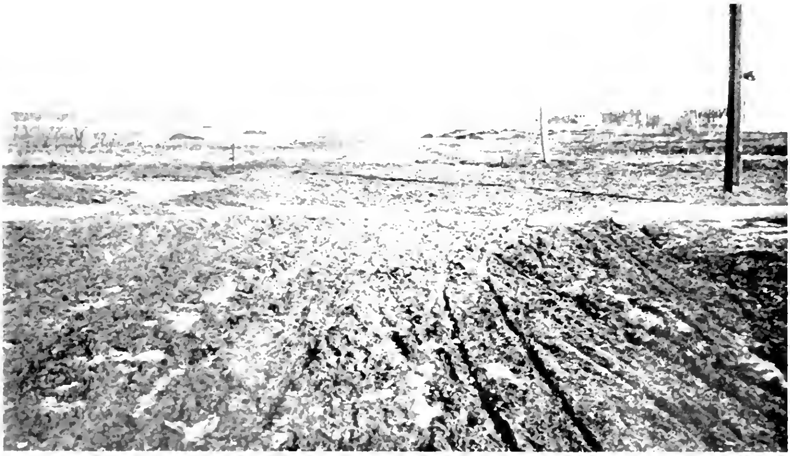
The most durable wood pavements are those made of the hard woods of Australia, which are especially adapted to this purpose.

GRANITE PAVEMENT ON ROADWAY OF BROOKLYN BRIDGE AFTER CONSTANT USE WITH VERY HEAVY TRAFFIC FOR SIXTEEN YEARS.

They are mostly of the eucalyptus family, the red gum, blue gum, black butt, tallow-wood, and mahogany. Mr. George W. Bell, in a pamphlet published in 1895, gives some remarkable statistics as to the durability of these pavements. He cites the case of George Street, in Sydney, which sustains a very heavy traffic, and on which

a wooden-block pavement had been in constant use for over ten years, without repair of any kind. The only piece of wood pavement of this class which has been laid in this country, to the writer's knowledge, is on Twentieth Street, between Broadway and Fifth Avenue, in the Borough of Manhattan, where, in 1896, the Australian "kari" wood was laid. The work was done with the greatest care, and the resulting pavement has proved quite satisfactory. When Fifth Avenue was lately repaved the use of this material was considered, but, on account of the popular prejudice against all wood pavements and the delay which would be involved in obtaining the blocks, the idea was abandoned.

When wood pavements are spoken of in most of our cities, the taxpayer pictures to himself the round cedar block so generally



Looking North from Beverly Road and East Fifteenth Street, Brooklyn, in March, 1899.

in use in Western cities. These are used on account of their cheapness. They are usually laid on one or two courses of plank. The blocks are round, from four to eight inches in diameter and six inches in depth, are set as closely as possible to each other, and the joints are filled with gravel, after which they are usually poured full of pitch. Such a pavement, when new, is quite agreeable to ride over. It soon, however, becomes uneven; the defective blocks quickly decay; the surface not being impervious to water, the wet foundation under a pavement with so little rigidity becomes soft, and the mud or slime works its way up between the blocks, and the process of decomposition is expedited. We hear sometimes of the floating pavements of Chicago. These are such cedar-block pavements which are said to rise with the floods of water filling the roadways after heavy rainfalls, and from specimens of the pave-

ment which may be seen in that city considerable sections must have floated away. The round block has nothing to recommend it but its cheapness, and this usually proves to be expensive economy. In Galveston, Texas, creosoted yellow pine blocks have been laid for some years with general satisfaction. They are laid directly on the fine sand, which is water-rammed so as to be very compact. The surface is formed with great care by a template to the exact

LOOKING NORTH FROM BEVERLY ROAD AND EAST FIFTEENTH STREET, BROOKLYN, IN OCTOBER, 1899.

grade and crown, and the joints are filled with similar fine sand. In Indianapolis creosoted blocks have been laid for several years, sixty thousand square yards having been put down during the past season. They are laid as closely as possible on a concrete foundation, with a sand cushion of one inch, and the joints filled with paving cement, composed of ten per cent of refined Trinidad asphalt and ninety per cent of coal-tar distillate, after which

the surface is covered with half an inch of clean coarse sand or granite screenings.

Improved wood pavements are a luxury. They have many points of superiority over asphalt. They are so considered in London, where their use is continued, although they require renewal

A New Cedar Block Pavement in Toronto.

oftener than asphalt, and much more often than granite. They will undoubtedly be used more frequently in this country when the people are willing to pay the additional cost for the quiet and freedom from dust and from the somewhat disagreeable glare of asphalt.

For a dozen years or more brick has been used for street pavements in the cities of the middle West. The use of this material is by no means new. It began in Holland in the thirteenth century, and in the seventeenth century the highway from The Hague to Scheveningen was paved with brick. In Amsterdam such pavements are said to last from ten to twenty years, or an average of fourteen years. After about ten years they are commonly turned over and relaid, after which they will last about four years more. The size in common use is about the same as that made in this country.

A good paving brick should be tough enough to withstand the wear to which a street surface is subjected without chipping or cracking, and should not absorb more than from two to four per cent of its weight of water after submersion for forty-eight hours. It has not the wearing qualities of granite, although there is one block on Ninth Avenue, in the Borough of Manhattan, which has been subjected to very heavy traffic for eight years, has had

no repairs to speak of, and its condition to-day compares very favorably with almost any street pavement of equal age which has been subjected to similar traffic.

Another kind of street improvement which must be considered is macadam. In small towns, and some quite large cities, most of the streets are improved in this way. When well maintained and kept smooth, but not too hard, it forms a most agreeable surface for driving. It should not, in the writer's judgment, be classed as a pavement at all, certainly not as a permanent one, and its use should be restricted to park drives and boulevards (for maintaining which liberal appropriations can be secured), and to suburban roads, where sewers and subsurface pipes have not yet been laid, and where temporary roads are required to furnish convenient communication between centers of population, and to assist in developing these districts.

Macadam has no place in a city street, nor is it wise to lay it on the entire width of a roadway. It best serves its purpose when laid in a comparatively narrow strip, leaving the sides of the road unimproved, except for the formation of earth gutters, so that the surface water can readily soak away where the soil is sufficiently porous.

AN OLD CEDAR BLOCK PAVEMENT.

Macadam is the most expensive of all street surfaces to keep in thoroughly good condition, and in this country it is rarely, if ever, so maintained, except in some of our park roads.

The pavement which is to-day, more generally than any other, superseding stone on all streets where the traffic is not excessive

nor the grades extreme, is asphalt. It is scarcely necessary to attempt to give a history of the use of this material, how its adaptability to paving purposes was first discovered by the improved condition of the roads over which it was hauled from the French mines for use in reservoir and tank linings, etc. The drippings from the carts were observed to have been compacted by travel until a smooth, hard roadway resulted. The first street to be paved with it was Rue Bergera, in Paris, in 1854, and it was so successful that in 1858 Rue St. Honore was similarly treated. An asphalt pavement was laid in Threadneedle Street, London, in May, 1869, and in Cheapside and Poultry in the fall of 1870, while in Berlin its use began in 1873.

EIGHTEENTH AVENUE, BROOKLYN; MACADAMIZED FULL WIDTH OF ROADWAY AND GUTTERS PAVED, WITH NO PROVISION FOR SURFACE DRAINAGE.

The laying of bituminous pavements in this country began in 1869, and they were first made of tar concrete, or Scrimshaw. Asphalt began to be used within the next year or two, and its popularity has been astonishing, as will be seen from the fact that on January 1, 1898, the area of this kind of pavement laid in the United States was, as nearly as could be ascertained, thirty million square yards.

There is a notable difference between the European and American asphalts. The former may be called natural and the latter artificial pavements. In the former the material, as it comes from the mine, is ground to a powder, heated, placed upon the foundation prepared for it, and tamped into approximately the same condition

as before it was disturbed, though usually the product of several mines is mixed in order to obtain the best percentage of bitumen, but nothing is added to or taken from the bituminous rock. In the pavement usually laid in America, on the other hand, only a small proportion of the material is brought from the asphalt deposits, the principal part of it (sand) being obtained near at hand. In the one case the cost of long ocean or rail transportation has to be paid on the entire mass forming the pavement, while in the other this expense attaches to but from twelve to fifteen per cent of the material. This, of course, is a great advantage, and at recent prices it is scarcely possible for the European rock asphalts to compete with the artificial ones.

The making of a pavement from one of the standard asphalts may be briefly described as follows: The material as found in Nature has this composition:

Bitumen	38.14	per cent.
Organic matter, not bitumen	7.63	"
Mineral matter	26.38	"
Water	27.85	"
	100.00	

This is cooked until the water has been driven off, and some of the mineral matter has settled.

The above analysis is of Trinidad Pitch Lake asphalt, and is a particularly favorable result. This material is too hard for use in making a pavement, and it has to be softened or fluxed by the addition of something which will accomplish this purpose. In order to do this there is usually added to each one hundred pounds of refined asphalt about eighteen pounds of heavy petroleum oil. After this addition we have the asphaltic cement ready to combine with mineral matter, which is so selected that when asphaltic cement is added at the rate of about seventeen pounds of the cement to eighty-three pounds of the other all the particles will be coated, and more could not be added without making the pavement too soft. What is found to accomplish this best is fine stone dust and sand.

The asphaltic cement and sand are heated separately to about 300° F. The stone dust is then added to and mixed with the hot sand in the proportion of from five to eighty in the case of fine, well-graduated sand, to fifteen to sixty-seven for coarse sands, having less variation in size. The asphaltic cement is then added, and the materials are mixed to a homogeneous mass, which is ready to be taken to the street. It should reach there at a temperature not less than 250°, and is spread with hot iron rakes so as to give usually a thickness of two inches after consolidation. After spreading, it is rolled with a hand roller, after which a small amount of hydraulic

cement is swept over the surface, and it is thoroughly rolled with a steam roller of not less than ten tons, the rolling to be continued as long as the roller makes any impression on the surface.

The foundation is usually of cement concrete about six inches thick, though asphalt pavements are often laid over old stone pavements. Between the foundation and the wearing surface there is generally laid what is called a binder course, one inch thick and formed of small broken stone, to which has been added asphaltic cement, the same as is used in making the wearing surface. Five or six pints of this cement are used to each cubic foot of stone.

The pavement just described is made from Trinidad asphalt, the material from which nearly all the earlier artificial asphalt

King's Highway, Brooklyn; Sixteen Feet in Center of Road Macadamized.

pavements in this country were made, and which was used almost exclusively until within the last half dozen years.

Within that time, however, it has been discovered that there are a number of other deposits of asphalt well adapted to use for street pavements. A very large deposit containing a high percentage of bitumen and very little mineral matter is located near the coast in the State of Bermudez, in Venezuela. Large deposits have been found in several places in California, and in Utah, Kentucky, and Texas, and a number of other places. The Kentucky product is classed as a natural rock asphalt, as it is a sandstone impregnated with bitumen. It has been mixed with about an equal portion of German rock asphalt and used with very satisfactory results in Buffalo. These asphalts are quite different in their com-

position, and each requires somewhat different treatment. The Bermudez, being richer in bitumen and softer, requires the addition of very little flux. The California deposits furnish their own flux in a liquid asphalt or maltha, which is almost absolutely pure bitumen, and the use of petroleum residuum is thereby avoided altogether.

It has been recognized since 1836 that the bitumen which forms the greater part of natural asphalts can be separated into two substances, which have been commonly known as petrolene and as-

Asphalt Pavement on Clinton Avenue, Brooklyn.

phaltene, the former of which possesses the cementitious qualities essential to the making of a successful pavement. Instead of the arbitrary names—petrolene and asphaltene—these substances are sometimes more aptly designated as active and inert bitumen. It has been found that of the bitumen extracted from asphalts which have given the most satisfactory results in making street pavements, sixty-nine per cent or more is soluble in petroleum naphtha having a specific gravity of 72° Beaumé.

An asphalt pavement can not be economically kept in good

condition unless every defect which may develop is immediately repaired. When the smooth, hard surface is once broken, disintegration proceeds very rapidly, and a large hole is soon formed. The more general distribution of smooth pavements, however, will tend to distribute the traffic more evenly, and the increasing use of rubber tires and rubber shoes for horses, to say nothing of the probably quite general use of motor vehicles, within the next decade will result in the elimination of the forces at present most destructive to pavements.

Much regret is often expressed that asphalt pavements should be so frequently opened for the purpose of laying or obtaining access to subsurface pipes and conduits, and thereby mutilated. As a matter of fact, there is no pavement at present in use which can be so effectively and satisfacortily restored as asphalt. When skillfully done, almost no trace of such an opening can be found.

The first question to arise, when it has been determined to pave a street, will be the selection of material, or the kind of pavement to be laid. In determining this, the governing considerations will be the traffic to be sustained, its density and character, the rate of grade, and the presence or absence of railroad tracks.

If the traffic be very heavy and the street given up wholly to business, ease of traction, durability, and economy of maintenance are of first importance, while quiet, comfortable riding, and beauty can be sacrificed to them. Many efforts have been made to determine the relative force required to draw a load over different kinds of surface under similar conditions. The following is from a table compiled by Mr. Rudolph Hering, from different authorities, the force being that necessary to move one ton on a level grade at a speed of three miles an hour:

Kind of Road.	Pounds.
Ordinary dirt road	224
Ordinary cobblestone	140
Good cobblestone	75
Common macadam	64
Very hard, smooth macadam	46
Good stone block	45
Best stone block (London)	36
Asphalt	17
Granite tramway	12½ to 13¼
Iron railway	8 to 11½

The question of durability occurs next, and the different kinds of pavement which may be considered for city streets may be rated as follows, it being assumed that the traffic is not excessively heavy:

Kind of Pavement.	Life in years.
Best granite block on concrete	30
Granite block laid on sand	20
Belgian trap	20
Cobblestone	18
Asphalt	15
Best wood—rectangular block	10
Vitrified brick	12
Macadam	8
Cedar block—round—on sand	5

No class of municipal work comes so near to the daily life of an urban population—both the business and the home life—as the surface improvement of city streets, and no expenditure is too great (provided the work is skillfully and honestly done) to make them smooth, clean, sanitary, and beautiful.

TYPICAL CRIMINALS.

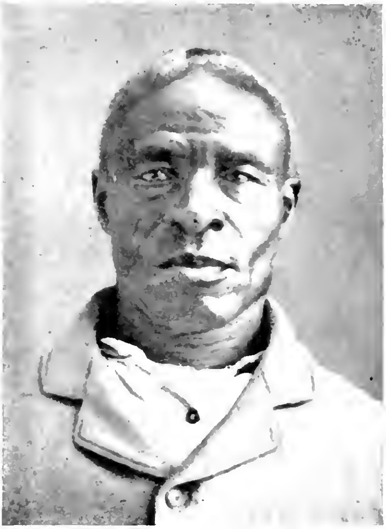
By SAMUEL G. SMITH, LL. D.

IF the question of a criminal type, defined by certain marks of a physical nature and emphasized by accompanying mental and moral characteristics, were confined to the technical speculations of a special craft of scientists, the public would have little interest in the spread of the doctrines of Cesare Lombroso and his *confrères* in this country. When it is believed, however, that certain men and women are committed to prison or condemned to death not on account of crimes in any ethical sense, but because of spontaneous actions from vicious impulses beyond their control, the subject affects the administration of law, the theory of punishment, and the safety of society.

Lombroso and the Italian school say that they have discovered a type of man who is born a criminal, and who may be recognized by a Mongolian face, abnormal features, ill-shaped ears, unsymmetrical skull, and various psychical peculiarities, which are the result of bad organization. This doctrine is illustrated by descriptions of criminals who have the abnormalities, and in the hands of skillful writers the case is made very plausible. The theory is in harmony with so much popular modern thought, which loosely interprets the doctrine of evolution by a crass materialism, that it has infected American prison literature, while it has never misled those men to whom practical experience has given the most right to have an opinion on the subject. The sense of personal responsibility is still the foundation of social order, and if in truth there is no such thing, the world is awake at last from its dream of morality;

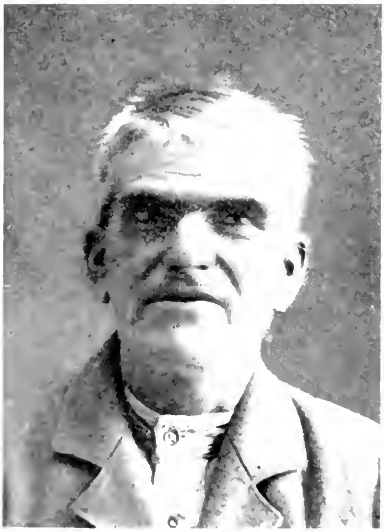
righteousness is resolved into heredity, structure, and habit; living is a mere puppet show, and the wreck of things impends. If Lom-

Group 1, No. 1.



Group 1, No. 2.

broso is right, modern scientific methods are sure to prove him so, and we shall have at last sound theories; but we shall have no world in which they can be used, for the dissolution predicted by Herbert Spencer will have come.

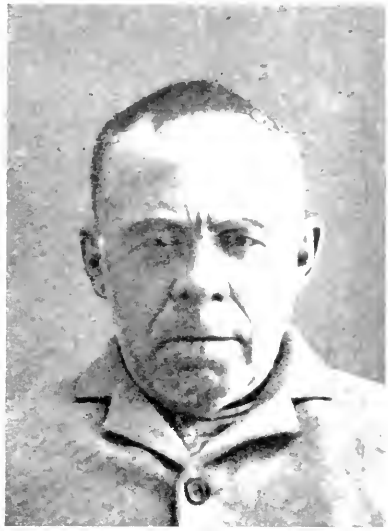


Group 1, No. 3.

Exceptional opportunities for the study of the abnormal classes in the institutions of this country and Europe have given me a personal interest in the question of the criminal type. I have discovered that the criminal anthropologists do not choose for comparison with the prison population their normal men from the ranks where the criminal classes are recruited. Blackwell's Island has no more peculiar inmates than abound in sections of New York near the East River; the residents of the Whitechapel district of London may be compared with the inmates of Pentonville, to the distinct credit of the latter; and the man in Roquette is no worse off

in body than scores whom I have seen in certain localities south of the Seine. The fact is, no human body exists which is not in some

Group 2, No. 1 (forger).



Group 2, No. 2.

respects abnormal. The number of abnormalities and their extent depend upon a variety of circumstances, among which are food, climate, occupation, and the incidents of birth itself, as well as the various forms of infantile disease. I will undertake to find enough physical peculiarities, in any locality, or among the members of any profession, to establish any physical theory which may be propounded.

Group 2, No. 3.

It occurred to me to try an experiment in a manner entirely different from the usual criminal researches. Having been very familiar with a certain prison for many years, I requested the warden, who is a very able man in his profession, to send me the photographs of ten or a dozen men whom he regarded as the most representative criminals in his population of some five hundred persons. The warden was not informed of the use I intended to make

of the material, and supposed it was for illustration in university class work. Later, he gave me the Bertillon measurements of the men, with an epitome of their history. A number of these men I have known for years. So far from this selection supporting the modern theory of a criminal type, it confutes it in a conspicuous manner. The abnormalities are slight, and there is as great a diversity among the men as could be asked. It must be remembered that these cases were selected by a shrewd and competent official, solely upon their criminal record, and not in the interests of any theory whatever.

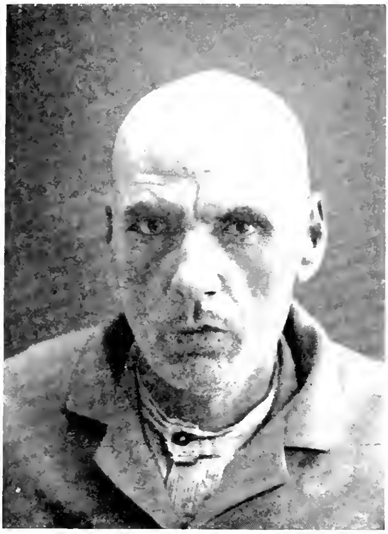
Of course, the men do not look well, but neither would any ordinary company of citizens if their heads were shaved and they were put in prison dress. I am always shocked by the changed appearance of the men after the prison transformation. Young embezzlers of elegant figure, who have moved in good society without a question, easily look the rascal behind prison walls.

The first group are murderers. No. 1 murdered his daughter because she insisted upon going to a party against his wishes. He has the head of a philosopher. It was his first crime. It may be noted that tattooing is supposed to be common among criminals. This man is tattooed, but committed no crime until fifty years of age, and was a deputy sheriff for some years. No. 2 did not kill his victim, but the assault was murderous, and the escape from death was accidental. It is difficult to discuss the negro in crime without entering into racial and social questions beyond the present limits. No. 3 has a very good head, an excellent ear, and, barring the expression, a pleasing face. He has a life sentence for murder. He is the worst man in the prison. I have for years believed him to be insane. His family is criminal. His father murdered his mother in a brutal manner before the child's eyes, when No. 3 was only eight years old. He himself has committed several desperate assaults, growing out of his persistent mania of persecution. No. 3 is not morally responsible, and there are usually two or three such prisoners out of a thousand subjects.

The second group are very diverse in structure and temperament, but have committed the same kind of crime. No. 1 is a confidence man and a forger. He is a crafty and an habitual criminal, has served terms in various prisons, is keen of intellect, well educated, has traveled in many countries, and is a citizen of the world.

No. 2 is a confirmed forger, and has served several terms in prison for the same offense. He is a skillful bookkeeper, has an attractive manner, and as soon as he is out in the world secures employment and plans his next crime.

No. 3 is a counterfeiter. His head is small, but of excellent shape, and he has rather a refined physical organization. His crimi-



Group 3, No. 1.

Group 3, No. 2.

nal record is bad, and he has served at least one term before for the same offense. His imagination, temperament, and vices would select him as a person who would be guilty of a very different and more fleshly kind of crime. The group is formed by the correlation of crime; they have nothing in common in physical organization.

Group 3, No. 3.

The third group are thieves. No. 1 is a confirmed criminal, and has served several terms in prison. He is the tallest man in the list. His head is "long" and well formed, and his features are regular. His expression indicates power of sustained thought, and his peculiar appearance is not due to his kind of crime, but to his habit of mind. He is a pessimist of the first rank, and hates the world, his fellow-men, and perhaps himself most of all. He will not work when at liberty, thinks that society

is totally depraved, and that war upon it is the only proper mission in life. He is pre-eminently the antisocial man.

No. 2 is really a pleasing fellow. He is tender, sympathetic, and pious. Under proper circumstances he might have made an admirable Sunday-school superintendent. He is plausible, insinuating, and winning. In temperament, feeling, and social habit he is the complete antithesis to No. 1. He is a most dangerous criminal, and has a black and varied record.

No. 3 is a man of lower grade of organization and habit, but he is a criminal by profession. He is an idle and worthless vagabond, but he is an accomplished thief. He makes an excellent prisoner, obedient to the rules, industrious, and seemingly anx-

Contrasts, No. 1.

Contrasts, No. 2.

ious to improve. In fact, the prison furnishes his best environment, for it is only there that he is at peace with himself and his world.

The last two men presented are contrasts. No. 1 is an accidental criminal. His previous history and character give strong grounds for the belief that, under pressure of want for the necessaries of life, he was led astray by a man older and stronger than himself. It is not likely that he would repeat his fault. No. 2, on the other hand, is a sexual pervert of the worst kind, whose case seems so hopeless that perpetual imprisonment is indicated as the only relief for him, and the only safety for society. Apart from the expression of his eyes, caused by an irregular focus, there is nothing marked about the face. The head is of a pronounced

"broad" type, but, on the other hand, he comes from a province of Germany where that type is dominant.

To complete the experiment, I submitted these portraits to a number of gentlemen, and to no two of them at the same time, for their opinions of the cases. The informal committee represented the different professions which might be expected to fit men for observation, for there was a lawyer, a physician, a railway president, a criminal judge, and a college professor. Each of them is eminent in his special field. The committee was manifestly handicapped by the shorn head, the prison dress, and the lack of the accessories of masculine ornamentation, such as collars and cravats. The committee was asked to name the crimes, and to group the men according to their criminal record. Each opinion differed from the other, and all were wide of the mark. The shrewd lawyer thought the accidental criminal "might be guilty of anything." It was only the college professor, the last man of the company from whom anything might properly be expected, who was able to select the worst two cases with the remark, "These men are degenerates." But while the committee was at work on the photographs the writer was at work on the committee, and actually discovered more anomalies of organization in these distinguished citizens than are apparent in the criminals. After this remark it is necessary to withhold their names, though some of them are men of national reputation.

It is time to reassert with increasing emphasis the personal responsibility of the individual, and to insist upon the enthronement and guidance of conscience. There are certainly social and economic reasons for crime, some of which the writer has pointed out elsewhere, but the chief fact in human life is the power of self-determination. The chief causes of crime, outside of personal and moral degradation, are psychical and not physical. The reader of history can not fail to have noted that relation of prevalent ideas to conduct which is so conspicuous in human affairs. The scenes of blood and desolation characteristic of the French Revolution are directly traceable to the doctrines which prepared the way for anarchy, but not for rational freedom.

We have had our attention directed to the contagion of suicide which has marked the last half decade. But Lecky tells us that suicide was made practically unknown in the civilized world by the spread of Christianity and its beliefs in the dignity and sanctity of man. The present contagion will disappear not as the result of food, or raiment, or houses, or any other material good, but by a revival of practical faith in the human soul and its capacity, in human righteousness and its obligation.

A CENTURY OF GEOLOGY.

By Prof. JOSEPH LE CONTE.

[*Concluded.*]

THE AGE OF THE EARTH.

UNTIL almost the beginning of the present century the general belief in all Christian countries was that not only the earth and man, but the whole cosmos, began to exist about six thousand to seven thousand years ago; furthermore, that all was made at once without natural process, and have remained substantially unchanged ever since. This is the old doctrine of the supernatural origin and substantial permanency of the earth and its features. Among intelligent and especially scientific men this doctrine, even in the eighteenth century, began to be questioned, although not publicly; for in 1751 Buffon was compelled by the Sorbonne to retract certain views concerning the age of the earth, published in his Natural History in 1749.* Remnants of the old belief lingered even into the early part of the present century, and may even yet be found hiding away in some of the remote corners of civilized countries. But with the birth of geology, and especially through the work of Hutton in Scotland, Cuvier in France, and William Smith in England, the much greater—the inconceivably great—antiquity of the earth and the origin of its present forms, by gradual changes which are still going on, was generally acknowledged. Indeed, as already said, this is the fundamental idea of geology, without which it could not exist as a science.

Geology has its own measures of time—in eras, periods, epochs, ages, etc.—but it is natural and right that we should desire more accurate estimates by familiar standards. How old, then, is the earth, especially the inhabited earth, in years? Geologists have attempted to answer this question by estimates based on the rates of sedimentation and erosion, or else on the rate of changes of organic forms by struggle for life and survival of the fittest. Physicists have attempted to answer the same question by calculations based on known laws of dissipation of energy in a cooling body, such as the sun or the earth. The results of the two methods differ widely. The estimates of the geologists are enormous, and growing ever greater as the conditions of the problem are better understood. Nothing less than several hundred million years will serve his purpose. The estimates of the physicists are much more moderate, and apparently growing less with each revision. The

* Lyell's Principles of Geology, eighth edition, p. 41.

latest results of King and Kelvin give only twenty to thirty millions.* This the geologist declares is absurdly inadequate. He can not work freely in so narrow a space—he has not elbow room.

The subject is still discussed very earnestly, but with little hope of definite conclusion. One thing, however, must be remarked. Both parties assume—the geologist tacitly, the physicist avowedly—the nebular hypothesis of the origin of the solar system, and therefore the early incandescent *fluid* condition of the earth as the basis of all his reasonings. Now, while this is probably the most reasonable view, it is not so certain that it can be made the basis of complex mathematical calculation. There is a possible alternative theory—viz., the meteoric theory—which is coming more and more into favor. According to this view, the planets may have been formed by aggregation of meteoric swarms, and the heat of the earth produced by the collision of the meteors in the act of aggregation. According to the one view (the nebular), the heat is all primal, and the earth has been only losing heat all the time. According to the other, the aggregation and the heating are both gradual, and may have continued even since the earth was inhabited. According to the one, the spendthrift earth wasted nearly all its energy before it became habitable or even a crust was formed, and therefore the habitable period must be comparatively short. According to the other, the cooling and the heating, the expenditure and the income, were going on at the same time, and therefore the process may have lasted much longer.

The subject is much too complex to be discussed here. Suffice it to say that on this latter view not only the age of the earth, but many other fundamental problems of dynamical geology, would have to be recalculated. The solution of these great questions must also be left to the next century. In the meantime we simply draw attention to two very recent papers on the subject—viz., that of Lord Kelvin,† and criticism of the same by Chamberlin.‡

ANTIQUITY AND ORIGIN OF MAN.

Even after the great antiquity of the earth and its origin and development by a natural process were generally accepted, still man was believed, even by the most competent geologists, to have appeared only a few thousand years ago. The change from this old view took place in the last half of the present century—viz., about 1859—and, coming almost simultaneously with the publication of Darwin's Origin of Species, prepared the scientific mind

* Clarence King, American Journal of Science, pp. 45–51, 1893; Kelvin, Science, vol. ix, p. 665, 1899.

† Science, vol. ix, p. 665, 1899.

‡ Ibid., p. 889, and vols. x and xi, 1899.

for entertaining, at least, the idea of man's origin by a natural process of evolution.

Evidences of the work of man—flint implements, associated with the bones of extinct animals and therefore showing much greater age than usually accepted—had been reported from time to time, notably those found in the river Somme by Boucher de Perthes. But the prejudice against such antiquity was so strong that geologists with one accord, and without examination, pooh-poohed all such evidence as incredible. It was Sir Joseph Prestwich who, in 1859, first examined them carefully, and published the proofs that convinced the geological world that early man was indeed contemporaneous with the extinct animals of the Quaternary period, and that the time must have been many times greater than usually allowed.*

Since that time confirmatory evidence has accumulated, and the earliest appearance of man has been pushed back first to the late glacial, then to the middle glacial, and finally, in Mr. Prestwich's Plateau Gravels, to the early glacial or possibly preglacial times.

Still, however, in every case earliest man was unmistakably man. No links connecting him with other anthropoids had been found. Very recently, however, have been found, by Du Bois, in Java, the skull, teeth, and thigh bone of what seems to be a veritable *missing* link, named by the discoverer *Pithecanthropus erectus*. The only question that seems to remain is whether it should be regarded as an ape more manlike than any known ape, or a man more apelike than any yet discovered. The age of this creature was either latest Pliocene or earliest Quaternary.

BREAKS IN THE GEOLOGICAL RECORD AND THEIR SIGNIFICANCE.

From the earliest times of geologic study there have been observed unconformities of the strata and corresponding changes in the fossil contents. Some of these unconformities are local and the changes of organic forms inconsiderable, but sometimes they are of wider extent and the changes of life system greater. In some cases the unconformity is universal or nearly so, and in such cases we find a complete and apparently sudden change in the fossil contents. It was these universal breaks that gave rise to the belief in the occurrence of violent catastrophes and corresponding wholesale exterminations and re-creations of faunas and floras.

It is evident, however, on a little reflection, that every such unconformity indicates a land period at the place observed, and therefore a time unrecorded in strata and fossils at that place—i. e.,

* Life and Letters of Sir Joseph Prestwich, pp. 124 *et seq.*

a lost interval—certain leaves missing from the book of time. And if the unconformity be widespread, the lost interval is correspondingly great. It is therefore probable that change of species went on slowly and uniformly all the time, although not recorded at that place. Intermediate strata may be and often are found elsewhere, and the supposed lost interval filled. The record was continuous and the changes uniform, but the record is not all found in one place. The leaves of the book of Time are scattered here and there, and it is the duty of the geologist to gather and arrange them in proper order, so that the record may read continuously.

This is the uniformitarian view, and is undoubtedly far truer than the catastrophic. But the objection to it is that in the case of very widespread unconformities, such as occurred several times in the history of the earth, the changes of organisms are so great that if the rate of change was uniform the lost interval must have been equal to all the rest of the history put together. Therefore we are compelled to admit that in the history of the earth there have been periods of comparative quiet (not fixedness) during which evolutionary changes were slow and regular, and periods of revolution during which the changes were much more rapid, but not catastrophic. This is exactly what we ought to expect on the idea of gradual evolution of earth forms by secular cooling, for in the gradual contraction of the earth there must come times of general readjustment of the crust to the shrinking nucleus. These readjustments would cause great changes in physical geography and climate, and corresponding rapid changes in organic forms. In addition to this, the changes in physical geography and climate would cause extensive migrations of species, and therefore minglings of faunas and floras, severer struggles of competing forms, and more rapid advance in the steps of evolution. Among these changes of organic forms there would arise and have arisen *new dominant types*, and these, in their turn, would compel new adjustment of relations and still further hasten the steps of evolution. Such changes, whether geographic, or climatic, or organic, would *not* be simultaneous all over the earth, but propagated from place to place, until quiet was re-established and a new period of comparative stability and prosperity commenced.

This view is a complete reconciliation of catastrophism and uniformitarianism, and is far more rational than either extreme.

Critical Periods in the History of the Earth.—Such periods of rapid change may well be called *critical periods or revolutions.* They are marked by several characteristics: (1) By widespread oscillations of the earth's crust, and therefore by almost universal unconformities. (2) By widespread changes of physical geography,

and therefore by great changes in climate. (3) By great and widespread changes in organic forms, produced partly by the physical changes and partly by the extensive migrations. (4) By the evolution of new dominant types, which are also the cause of extensive changes in species. (5) Among the physical changes occurring at these times is the formation of great mountain ranges. The names of these critical periods or revolutions are often taken from the mountain range which form their most conspicuous features.

There have been at least four of these critical periods, or periods of greatest change: (1) The pre-Cambrian or Laurentide revolution; (2) the post-Paleozoic or Appalachian; (3) the post-Cretaceous or Rocky Mountain; (4) the post-Tertiary or glacial revolution.

Now, as these critical periods separate the primary divisions of time—the eras—it follows that the *Present*—the Age of Man—is an era. It may be called the *Psychozoic Era*. These views have been mainly advocated by the writer of this sketch, but I believe that, with perhaps some modification in statement, they would be accepted by most geologists as a permanent acquisition of science.*

GEOLOGICAL CLIMATES.

Attention was first drawn to this subject by the apparently unique phenomena of the Glacial epoch.

For nearly a century past Alpine glaciers, their structure, their mysterious motion, and their characteristic erosive effects, have excited the keenest interest of scientific men. But until about 1840 the interest was purely physical. It was Louis Agassiz who first recognized ice as a great *geological agent*. He had long been familiar with the characteristic marks of glacial action, and with the fact that Alpine glaciers were far more extensive formerly than now, and had, moreover, conceived the idea of a Glacial epoch—an ice age in the history of the earth. With this idea in his mind, in 1840 he visited England, and found the marks of glaciers all over the higher regions of England and Scotland. He boldly announced that the whole of northern Europe was once covered with a universal ice sheet. A few years later he came to the United States, and found the tracks of glaciers everywhere, and again astonished the world by asserting that the whole northern part of the North American continent was modeled by a moving ice sheet. This idea has been confirmed by all subsequent investigation, especially here in America.

* Critical Periods, etc., American Journal of Science, vol. xiv, p. 99, 1877; Bulletin of the Geological Department of the University of California, vol. i, No. 11, 1895.

But it would be strange, indeed, if the cold of the Glacial epoch should be absolutely unique. Attention was soon called to similar marks in rocks of other geological periods, especially in the Permian of the southern hemisphere. This opened up the general question of *geological climates and their causes.*

Perhaps no subject connected with the physics of the earth is more obscure and difficult than this. The facts, as far as we know them, are briefly as follows: (1) All the evidence we have point to a high, even an ultra-tropical, climate in early geological times; (2) all the evidence points to a uniform distribution of this early high temperature, so that the zonal arrangement of temperatures, such as characterizes present climates, did not then exist; (3) temperature zones were apparently first introduced in the late Mesozoic (Cretaceous) or early Tertiary times, and during the Tertiary the colder zones were successively added, until at the end there was formed a polar ice-cap as now.

Thus far all might be explained by progressive cooling of the earth and progressive clearing of the atmosphere of its excess CO_2 and aqueous vapor. But (4) from time to time (i. e., at critical periods) there occurred great oscillations of temperature, the last and probably the greatest of these being the Glacial period. The cause of these great oscillations of temperature, and especially the cause of the glacial climate, is one of the most interesting and yet one of the obscurest and therefore one of most hotly disputed points in geology. Indeed, the subject has entered into the region of almost profitless discussion. We must wait for further light and for another century. Only one remark seems called for here. It is in accordance with a true scientific method that we should exhaust terrestrial causes before we resort to cosmical. The most usual terrestrial cause invoked is the oscillation of the earth's crust. But recently Chamberlin, in a most suggestive paper,* has invoked oscillations in the composition of the atmosphere, especially in its proportion of CO_2, as the *immediate* cause, although this in turn is due to oscillations of the earth's crust.

THE NEW GEOLOGY.

Heretofore the geological history of the earth has been studied only in the record of stratified rocks and their contained fossils. But in every place there have been land-periods in which, of course, erosion took the place of sedimentation. This kind of record is very imperfect, because there are no fossils. Until recently no account was taken of these erosion-periods except as

* Journal of Geology, vol. vi, p. 597, 1898, and vol. vii, p. 545, 1899.

breaks of indefinite length in the record—as lost intervals. But now, and mainly through the work of American geologists, interpretation of these erosion-periods has fairly commenced, and so important has this new departure in the study of geology seemed to some that it has been hailed as a new era in geology, connecting it more closely with geography. Heretofore *former* land periods were recognized by unconformities and the amount of time by the degree of change in the fossils, but now the amount of time is estimated in *existing* land surfaces by topographic *forms* alone. This idea was introduced into geology by Major J. W. Powell, and has been applied with success by William Morris Davis, W J McGee, and others.

The principle is this: Land surface subject to erosion and standing still is finally cut down to gently sweeping curves, with low, rounded divides and broad, shallow troughs. Such a surface is called by Davis a Peneplain. Such a peneplain is characteristic of old topography. If such a surface be again lifted to higher level, the rivers again dissect it by ravines, which are deep and narrow in proportion to the amount and rate of the uplift. If the land again remains steady, the sharply dissected surface is again slowly smoothed out to the gentle curves of a peneplain. If, on the contrary, the surface be depressed, the rivers fill up the channels with sediment which, on re-elevation, is again dissected. Thus the whole *ontogeny* of land surfaces have been studied out, so that their age may be recognized at sight.

Thus, while heretofore the more recent movements of the crust were supposed to be readable only on coast lines and by means of the old sea strands, now we read with equal ease the movements of the interior by means of the physiognomy of the topography, and especially the structure of the river channels. Moreover, while heretofore the history of the earth was supposed to be recorded only in stratified rock and their contained fossils, now we find that recent history is recorded and may be read also in the general topography of the land surfaces. Geography is studied no longer as mere description of earth forms, but also as to the causes of these forms, no longer as to present forms, but also as to the history of their becoming. Thus geography, by its alliance with geology, has become a truly scientific study, and as such is now introduced into the colleges and universities. It is this alliance with geology which has caused the dry bones of geographic facts to live. It is this which has created a soul under the dry "*ribs of this death.*" This mode of study of the history of the earth has just commenced. How much will come of it is yet to be shown in the next century.

In this connection it is interesting to trace the effect of environment on geological reasonings in different countries. Heretofore, especially in England, what we have called peneplains were usually attributed to marine denudation—i. e., to cutting back of a coast line by constant action of the waves, leaving behind a level submarine plateau, which is afterward raised above sea level and dissected by rivers. American geologists, on the contrary, are apt to regard such level surfaces as the final result of aërial degradation or a base level of rain and river erosion. The same difference is seen in the interpretation of glacial phenomena. Until recently, English geologists were inclined to attribute more to iceberg, Americans more to land ice. Again, in England coast scenery is apt to be attributed mainly to the ravages of the sea, while in America we attribute more to land erosion combined with subsidence of the coast line. In a word, in the tight little sea-girt island of Great Britain, where the ravages of the sea are yearly making such serious inroads upon the area of the land, it is natural that the power of the sea should strongly affect the imagination and impress itself on geological theories, and tend perhaps to exaggeration of sea agencies, while the broad features of the American continent and the evidences of prodigious erosion in comparatively recent geological time tend to the exaggeration of erosive agency of rain and rivers. These two must be duly weighed and each given its right proportion in the work of earth sculpture.

PALEONTOLOGY.

Paleontology at first attracted attention mainly by the new and strange life forms which it revealed. It is the interest of a zoölogical garden. This interest is of course perennial, but can hardly be called scientific. Geology at first was a kind of wonder book.

Next fossils, especially marine shells, were studied as characteristic forms denoting strata of a particular age. They were coins by which we identify certain periods of history. They were "medals of creation." It was in this way chiefly that William Smith, the founder of English stratigraphic geology, used them. It was in this way that Lyell and all the older geologists, until the advent of evolution, were chiefly interested in them.

It was Cuvier, the great zoölogist and comparative anatomist, who, in the beginning of the present century, first studied fossils, especially mammalian fossils, from the *zoölogical* point of view—i. e., as to their affinities with existing animals. Cuvier's studies of the vertebrates of the Paris basin may be said to have laid the foundation of scientific paleontology from this point of view.

Thenceforward two views of paleontology and two modes of study gradually differentiated from one another, the one zoölogical, the other geological. In the one case we study fossils in *taxonomic* groups—i. e., as species, genera, families, orders, etc.—and trace the gradual evolution of each of these from generalized forms to their specialized outcomes, completing as far as possible the genetic chain through all time. In the other we study fossils in *faunal groups*, as successive geological faunas, and the geographic diversity in each geological period—i. e., the evolution of geologic faunas and the causes of geographic diversity in each. In a word, we study the laws of distribution of faunas in time geologically and in space geographically, and the causes of these laws in each case. The first is strictly a branch of zoölogy and botany, and we leave it to these specialists. The second alone belongs properly to geology. In this purely geologic paleontology, as seen from its scope given above, there are many questions of widest philosophical interest which are only now attracting the attention they deserve. I only touch lightly two which have been brought forward in these very last years of the century.

I. General Laws of Faunal Evolution.—The evolution of the organic kingdom from this strictly geological point of view may be briefly formulated as follows:

1. Throughout all geological time there has been a general movement upward and onward, as it were abreast, everywhere. If this were all, there would be only geological progress, but no geographical diversity. Geological history would be the same everywhere. A time horizon would be easily determined by identity of fossil species. This we know is not true. Therefore there are other elements besides this.

2. In different countries, isolated from one another and under different conditions, evolution takes different *directions* and different *rates*, producing geographical diversity in each geological period. This diversity increases with time as long as the isolation continues. If this were all, the geographical diversity by continued divergence would have become so great that it would be impossible even approximately to determine any geological horizon. The history of each country must be studied for itself. A general history of the earth would be impossible. But this also is not true. There is therefore still another element.

3. From time to time, at long intervals—i. e., *critical periods*—there are widespread readjustments of the crust to internal strain, determining changes of physical geography and of climate, and therefore wide migrations of species with mingling and conflict of faunas. This would produce more rapid movement of evolution,

but at the same time more or less complete obliteration of geographical diversity.

4. After these periods of migrations and minglings there would be re-isolations in new localities, and the process of diversification would recommence and increase as long as the isolation continues.

The last of these critical periods of migrations and minglings and struggles for life among competing species was the *Glacial epoch* or ice age. Therefore the present geographical distribution of species was largely determined by the extensive migrations of that time.

II. Cosmopolitan and Provincial Faunas.—There are apparently in the history of the earth periods of widespread or cosmopolitan faunas, alternating with localized or provincial faunas. The cosmopolitan periods are usually times of prevalence of limestones or organic sediments, and the fossils are very abundant. The provincial periods are usually characterized by sandstones and shales or mechanical sediments, and are comparatively poor in fossils. Moreover, it is believed that the cosmopolitan limestone periods are oceanic periods—i. e., periods of wide oceans and lower and smaller continents and little erosive activity, while the sandstone periods, characterized by provincial faunas, are periods of higher and larger continents, and therefore of great erosion and abundant mechanical sedimentation.

Now, according to Chamberlin, these remarkable alternations are due to oscillations of the crust, in which the continents are alternately lifted and depressed. It must be remembered that abyssal faunas are almost unknown among fossils. This is the necessary result of substantial permanency of oceanic basins. The whole geological record is in shallow-water faunas. These shallow waters are along continental shore lines and in interior continental seas. According to Chamberlin again, during a period of continental depression all the flat continental margins are submerged, forming broad submarine platforms, and the lower interior portions of the continents are also submerged, forming wide and shallow interior seas. Under these conditions continental waste, and therefore sand and clay sediments, are reduced to a minimum. Life, animal and vegetal, abounds, and therefore much limestone is formed. The oceans are widely connected with one another, and therefore the faunas are widespread or cosmopolitan. During the period of elevation, on the contrary, the continents are extended to the margin of the deep oceanic basins, the broad, shallow submarine platforms are abolished, the interior seas are also abolished, the shallow-water areas are reduced to isolated bays, and their faunas are peculiar or provincial. Also, elevated and enlarged continents

give rise to maximum erosion, and therefore abundant sediments of sandstone and clay, and comparative poverty of life and therefore of limestone. Chamberlin also gives reasons why the oceanic periods should be warm, humid, equable in temperature, and the atmosphere highly charged with CO_2, and therefore highly favorable to abundant life, both vegetal and animal, while land periods would be drier and cooler, the atmosphere deficient in CO_2, and therefore cold from that cause and in many ways unfavorable to abundant life.

These extremely interesting views, however, must be regarded as still on trial, as a provisional hypothesis to be sifted, confirmed, or rejected, or in any case modified, in the next century.

Lastly, it is interesting to note the ever-increasing part taken by American geologists in the advance of this science. There has been through the century a gradual movement of what might be called the center of gravity of geological research westward, until now, at its end, the most productive activity is here in America. This is not due to any superiority of American geologists, but to the superiority of their opportunities. Dana has well said that *America is the type continent of the world.* All geological problems are expressed here with a clearness and a simplicity not found elsewhere. We must add to this the comparative recency of geological study in this rich field. In Europe the simpler and broader problems are already worked out, and all that remain are difficult problems requiring much time. In America, on the contrary, not only are all problems expressed in simpler terms, but many great and broad problems are still awaiting solution. For these reasons the greatest activity in research, and the most rapid advance during the next century, will probably be here in America.

"SALAMANDERS" AND "SALAMANDER" CATS.

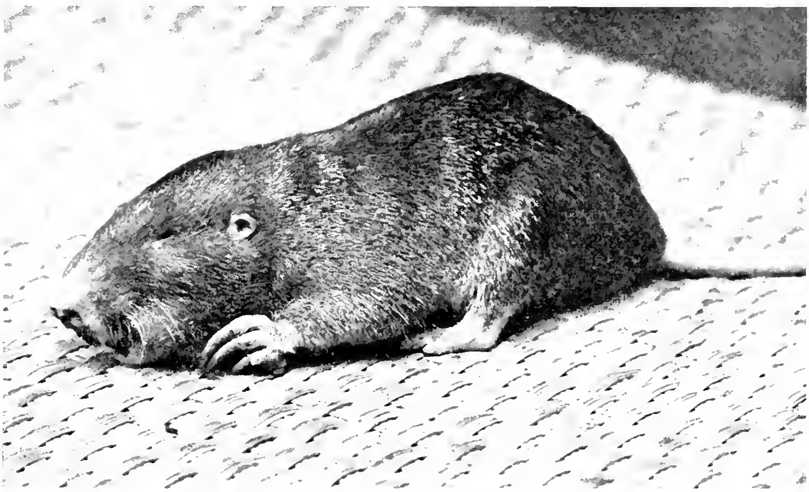
By NORMAN ROBINSON.

IN many places in the extreme Southern States, especially in what is locally known as the "piney woods," one of the most notable features is the constantly recurring mounds of yellow sand which everywhere dot and, it must be confessed, disfigure the monotonous landscape. These piles of earth are usually nearly circular in form, fairly symmetrical in contour, from six inches to two feet in diameter, and, save where they have been beaten down by rain or winds or the trampling of cattle, about half as high as they are broad. Often these sand heaps are pretty evenly distributed, sometimes so thickly as to cover at least one fourth of the

soil surface. If you ask a native the cause of this singular phenomenon, which you will perhaps at first be disposed to consider a kind of arenaceous eruption which has somehow broken out on the face of Nature, your informant will sententiously reply, "Salamanders!"

All this disfigurement is indeed the work of a curious little rodent popularly so named and about the size and color of an ordinary rat. He is never seen above ground if he can possibly help it. He digs innumerable branching underground tunnels at depths varying from one to six feet, and these mounds of sand are simply the "dump heaps" which, in his engineering operations, he finds it necessary to make.

After carrying the excavated earth to the surface this cautious little miner takes the greatest pains to cover up his tracks. No



"Snap-shot" View of a Live "Salamander."

opening into his burrow is left. How he manages to so carefully smooth over his little sand mound and then literally "pull the hole in after him" is as yet unexplained. The work is mostly done at night, when observation is especially difficult. Sometimes, when he is a little belated and the early morning twilight admonishes him that it is "quitting time," he gets in a hurry and slights his work. Then a little depression at the top of the mound tells where he has made a hasty exit. Ordinarily the rounding out of the sand pile is as deftly done as though it had all been managed from above. Indeed, the feat actually accomplished by this little underground builder appears more puzzling the more it is considered. The most skilled human engineer would confess his inability to

thus pile up a mound of loose sand, go down through it, leave the top perfectly smoothed over, and, with no supports save the sand itself, to so fill up the passageway above him as he went down that not the slightest mark should be left to indicate his pathway of retreat.

Even if you dig into and under one of these sand mounds you will find very little to betray the builder's whereabouts. It is seemingly all solid earth, and unless you know exactly when and where and how to dig you will probably give up the search in disgust, with your labor and your backache but no "salamander" hole for your pains. Indeed, the cunning of this little rodent in hiding his burrow is quite as conspicuous as his skill in digging it. "Strategy" is his strong point. If by any chance you come upon his burrow it is probably an old abandoned one that is closed up and leads nowhere. The chances are ten to one that his real burrow is rods if not furlongs away.

Provided you can find the last mound he has built and not more than four or five hours have elapsed since its completion, by digging diagonally to the right or left, at the distance of a foot or so, you will have a fair chance of encountering his burrow. He is probably near by, resting from the severe labors of the previous night. If you give him time to get his nap out and finish his job, your wiser plan will be to stop hunting and digging a little before you begin.

Why this little underground dweller should be called "salamander" is one of those mysteries of popular nomenclature which is seemingly inexplicable. There is certainly nothing in the habits or appearance of the animal to suggest the fabled fireproof batrachian. Like some other lovers of darkness, he has quite a number of *aliases* by which in various portions of the South and West he is known. "Gopher," "pouched rat," "hamster," and "muelos" are some of the titles by which he is locally known. "Salamander" appears to be the most generally accepted one.

This enterprising little rodent belongs to an ancient if not honorable family. By naturalists he is generally known as "pocket gopher," and is classed among the *Geomyidæ*. Some fifteen known species have been recognized, with possibly more to hear from, and with a habitat extending quite across the continent. The Florida species is probably *Geomys tuza* (Ord.), and though not as large as one or two others, is quite the peer of any of his cousins in enterprise and ability to look out for himself.

The illustration given is from what is probably the only photograph of a living "salamander" ever taken. Mr. Geomys is not a model "sitter." No unwilling candidate for the "rogues' gal-

lery" has more decided views on the subject of having his picture taken. In a general way, it may be said that he doesn't pose for anybody. Precisely how this prejudice was finally overcome it is needless to state. Perseverance and "snap shots" were too much for our recalcitrant rodent. In the matter of "looking pleasant" it must be conceded that Mr. Geomys was a little intractable.

The fore legs and feet of the "salamander" are worth studying. They remind one somewhat of those of the mole, but are more stoutly built, with much longer claws, and are evidently designed

"Dump Heaps" of the "Salamander."

for harder tasks. They are controlled by powerful brachial and pectoral muscles, and, as we shall see, are not only special tools adapted to special and difficult work, but work which requires an enormous expenditure of physical force.

The engineering problems which this little troglodyte has to solve are far and away ahead of any that the New York Rapid-Transit Commission has to deal with. It is very much as though a single miner were placed over in Hoboken, a hundred feet below the surface, with instructions to tunnel under the Hudson River

with no tools except his hands, without a chance of seeing daylight until he reached it on the New York side, and with the added conditions that all the excavated earth should be carried out at the eastern opening of the tunnel, and finally that he should obliterate all marks of his work and, as he retreated into his tunnel, pack the exit shaft above him so tightly and so deftly that it is impossible to trace its course!

How our little fur-coated engineer solves all these problems is as yet a mystery. We only know that he does it. He has a steam engine in his shoulders and shovels for hands, but his exact methods of using them is as yet largely a matter of conjecture. Only two plans of operation would seem to be possible. One would be for the "salamander" to first carry the excavated earth all to the rear into some portion of his already finished tunnel, and finally, when the outward exit is completed, to carry it back again and deposit it on the surface. This, of course, involves a double transfer of all the earth removed. It is more likely that the "salamander" first forces a narrow passageway along the line of his future tunnel in a way similar to that pursued by the mole. The latter animal has the advantage of working near the surface, and the earth always yields along the line of least resistance, which of course is upward. Four or five feet down there is no such line, and the amount of force required to push the ground aside must be something enormous. When the "salamander" comes to the upper air the work of excavation and enlargement begins. He then piles upon the surface all the earth that he can not use in obliterating his upward passageway. As the writer has frequently observed fresh sand mounds hundreds of feet from any others, he is inclined to believe that this is the real method pursued.

The exceeding care which the "salamander" takes to leave no opening into his subterranean home arises, no doubt, from his horror of snakes. In this respect no woman can surpass him. His antipathies to reptiles are probably the accumulated embodiment of hundreds of centuries of ancestral experience. He is aware that these hereditary enemies of his race are of a very investigating turn of mind, and put in a good deal of spare time when awake in crawling into and exploring any tempting hole they may discover. And so Mr. Geomys, like the sensible fellow that he is, not only takes good care to shut and lock his front gate every time he is compelled to go through it, but he blocks up the whole passageway and does his best to convince trespassers that it is all a mistake to suppose that there ever has been any roadway leading to his underground home.

Indeed, it is by taking advantage of this morbid antipathy to intruders and daylight that our little underground dweller is usually caught. If by skillful digging a recently formed burrow is reached, one may be reasonably certain that in from five to ten minutes Mr. "Salamander" will be on hand to see what has happened and to repair damages. A shotgun kept steadily aimed at the opening, and with a quick pull on the trigger the instant the slightest movement in the sand is seen, "fetches" him every time. Another very successful method is to place a strong trap right at the opening into his burrow. In making repairs our "salamander" is in too big a hurry to look very carefully where he steps, and so is quite likely to blunder into the trap. He is always caught, however, by one of his legs, and if left any length of time is quite apt to gnaw off the captive limb and thus make his escape. Spartan bravery or love of freedom surpassing this would be hard to find.

The food of *Geomys bursarius* appears to be exclusively vegetable. Native roots and root stocks, cones and bulbs, together with the root bark of various trees, are eaten by him, and sometimes in a very annoying way. Orange trees are peculiarly liable to his attacks. He gnaws through and around the tap root as near to the surface as he can without disturbing it or in any way calling attention to his work, and not infrequently he continues his depredations until every root of any size is eaten off. This, of course, means the death of the tree.

From the "salamander" point of view, however, the greatest food "bonanza" of all is a sweet-potato patch. "A 'possum up a 'simmon tree" or a "pig in clover" is not more alive to the delights and advantages of the situation. He not only eats all he can stuff, but invites his relatives and friends. Nor is this all. He has learned that in autumn sweet potatoes are liable to suddenly disappear, so he "takes time"—and the potatoes—"by the forelock," and packs them away in liberal measure in his burrow for winter use. So well understood are the ways and weaknesses of this underground marauder that any suspicious mound of earth in a sweet-potato field is the signal for an active campaign of extermination, which ends only in the intruder's flight or death.

The "side pockets" of the "salamander" have already been referred to. They are undoubtedly a great convenience to their owner in carrying food and possibly other things. The capacity of these cheek pouches is about sufficient to give room for a pigeon's egg. They are, however, quite extensile, and can readily be made to hold three or four times this amount. Indeed, the skin and underlying connective tissue are so elastic that these pockets can

readily be turned inside out. It is claimed that the "salamander" employs his handlike fore feet to fill and empty these receptacles, using the right foot for the left pouch, and *vice versa*. A gentleman in Florida recently assured me that by a lucky thrust of a spade he once killed one of these mischievous rodents as he was in the very act of cutting off the roots of an orange tree. The cheek pouches of the culprit were filled with fragments of bark which he had gnawed off, doubtless to be stowed away in his burrow.

Why, in a climate where there is almost no winter, where there is very little interruption to vegetable growth and the food supply is practically unlimited, provisions should thus be stored away is somewhat difficult to explain. It is not impossible that it is simply the survival of an ancestral habit acquired during the Glacial period. Or it may be that, like the dog, the "salamander" finds the flavor of old and well-seasoned food more to his taste. All that can be positively affirmed is that this wise little rodent does, occasionally at least, thus *caché* his food supplies.

One of the most curious results of the existence and habits of this elusive little burrowing rodent is the development of a new and peculiar breed of *Felis domestica*, called "salamander" cats. Ordinary tabbys do not understand or admire the ways of *Geomys bursarius*, or, for some other good and sufficient feline reason, do not include him in their game list. The variety of cats in question, which, so far as the author knows, is confined to Florida, appears to have been developed spontaneously and with very little if any human agency, and is noted for its special skill in catching "salamanders," as well as a decided liking for the sport. Any Mrs. Tabby of this breed, especially if she has a family to provide for, is up betimes in the morning. The particular object of her pursuit is a remarkably early riser, and finishes his day's work before most people have begun theirs. So if there is a convenient fence around the grounds she proposes to hunt she mounts it with the first peep of day, and, with a sharp eye to landward, starts on her tour of observation. Any fresh pile of sand is closely scrutinized. The slightest movement there brings her to the mound with a spring, and she is at once crouching behind it; so when Mr. Geomys comes up in a big hurry with his next load of sand he finds somebody to meet him that is in a bigger hurry still, and so the unsuspecting victim is borne off in triumph.

An estimable lady of the writer's acquaintance who owned one of these "salamander" cats, with a single juvenile pussy to provide for, kept an accurate account of the number of these rodents which she saw this industrious mother cat bring to her offspring in a single month. The number was thirty, and as the month hap-

pened to be February this gave, of course, two more than a "salamander" a day.

One other curious observed feature of this new variety of cats is their want of fecundity. The mother tabby seldom has more than one kitten at a birth. The writer once owned a fine female of this breed that scrupulously adhered to the traditional habits of her race.

This particular pussy, like the rest of us, had her family troubles. Her one kitten—probably from its mixed parentage—was always inclined to rebel at the "salamander" diet. There was something amusing to a degree and suggestively human in the old cat's methods of discipline. When she had succeeded in catching a salamander she would always first bring it and lay it down before her mistress, to make sure of the praise and the petting. Then, with a motherly "*meow*," she would call her kitten. That frisky little youngster was always quite ready for his breakfast, but showed a decided preference for the "maternal font." Then the old cat would give him a "cuff" that would send him spinning. Then she would take up the "salamander" and put it down before her hopeful offspring with an air that said as plainly as words could do: "There, now! Eat that or go hungry!" Then her mother love would get the better of her and she would go to licking and petting her disobedient baby, and it would usually end in the kitten's having its own way and satisfying its hunger with milk from the "original package." By persistence and the force of example the old cat finally succeeded in accustoming her offspring to what she evidently thought the orthodox diet of her race.

The writer is quite well aware of the intrinsic difficulties involved in the spontaneous development of any new variety of cats. Still, such branching of types has occurred in the past, and of course is possible now. When his attention was first called to the matter he was inclined to consider it merely an instance of animal education. A fact that came under his personal observation seems, however, hard to reconcile with this or any theory that does not concede the hereditary transmission of acquired habits and tastes.

A kitten of the breed of cats in question was taken when very young and reared nearly a mile away from its mother. When grown it developed the same skill in hunting "salamanders," and the same love for the sport as that for which its mother was celebrated.

Dogs, of course, have long been noted for the readiness with which acquired knowledge, habits, and tastes manifest and perpetuate themselves in hereditary forms. The setter, pointer, col-

lie, St. Bernard, and other well-known breeds will occur to everyone as illustrating this psychic plasticity. Doubtless the cat brain is somewhat less impressible, but there would seem to be good reasons for including it among the educably variable types.

WHAT MAKES THE TROLLEY CAR GO.

By WILLIAM BAXTER, Jr., C. E.

III.

ALTHOUGH the electric railway has been introduced throughout the civilized world with the most remarkable rapidity, replacing cable as well as horse roads, there has always been a strong opposition to the use of the overhead trolley, and in some places, as, for instance, the city of New York, this opposition has been so strong as to prevent the introduction of the system until some other means of conveying the current to the moving cars was devised. Many attempts have been made to solve this problem, and the patents taken out on such devices can be numbered by the hundred and possibly by the thousand. Inventors in this field, however, have not met with all the encouragement they could desire, owing to the fact that, notwithstanding opposition, the overhead trolley has been permitted in all but about three or four of the larger cities of this country, and the greater portion of those of other countries. The principal well-founded objection that can be raised against the trolley is that it is unsightly and destroys the appearance of the street, but those who are opposed to it also claim that it is dangerous, and that underground or surface systems would not be. As a matter of fact it is not dangerous, and there is nothing on record to show that it is. Many persons have been run over by trolley cars, but this is no fault of the overhead trolley; it is due to the fact that street railroads are permitted to run cars through crowded streets at a speed that is too great for safety. Underground conduit cars running at the same speed would run over just as many people. In accusing the trolley of being dangerous it is sought to prove that the current flowing in the wire can do harm; but the history of the numerous roads in existence shows that, so far as human beings are concerned, the trolley current is not fatal, although it can give a decidedly unpleasant shock, such as one would not care to experience the second time. There is

Note.—Figs. 28 and 32 are reproductions of photographs kindly furnished by the General Electric Company, while for the view of car, Fig. 30, we are indebted to Colonel N. H. Heft, chief electrical engineer of the New York, New Haven, and Hartford Railroad.

just as great, if not greater, liability of obtaining shocks from underground systems as from the trolley, therefore the only real gain that can be made by their use is in the artistic sense. From a financial point of view no underground system so far devised can compare with the overhead trolley; but if any one should devise anything hereafter that can be constructed at the same expense and will not cost more for maintenance it will undoubtedly find an extensive application. Until such a perfect solution of the problem makes its appearance the field for these devices will be confined to cities like New York and Washington, where the overhead trolley is not permitted.

Every system of conductors that dispenses with the overhead wire is called by the layman an underground trolley, but, properly speaking, these systems may be divided into surface and subsurface conductors. Both of these may again be divided into exposed and inclosed conductors, and also into continuous and sectional conductors. Finally, we may designate the various modifications as mechanical, electrical, and magnetic, the mechanical being those that accomplish the result by purely mechanical means, the electrical being those that employ electrical devices, and the magnetic those that depend for their action upon the attraction of magnets. The principal difficulties that the inventors in this field have to contend with are the cost of construction and the effective insulation of conductors. With the overhead trolley the current flows out from the power house to the cars through wires carried on poles, and the poles are themselves good insulators; but to make the work doubly sure the conductors are secured to glass insulators, which are practically perfect. The current returns to the power house through the ground and the track rails. As it is easier for the current to circulate in a short path than in a long one, there is a continual tendency for it to jump from the overhead wire through the insulation to the ground, but this is effectually prevented by the very perfect character of the insulation. When the outgoing and incoming wires are both placed upon or underground the strain upon the insulation is very much increased, for then instead of the two lines being separated by fifteen or twenty feet of pole, which is a very fair insulator, they are separated by only a few inches of earth or perhaps metal, the first of which is a fairly good conductor, while the last is a nearly perfect one. It is evident, therefore, that the insulation proper in an underground or surface system must be of the highest order. If the conduits in which the wires are located could be kept perfectly dry, there would be no difficulty in obtaining insulation that would withstand the strain it is subjected to; but rain in summer and snow in winter will at

times cover the tracks and fill the conduits, hence the securing of perfect insulation presents great difficulties. The manner in which inventors have sought to surmount the obstacles can be made clear by the aid of a few illustrations of typical designs.

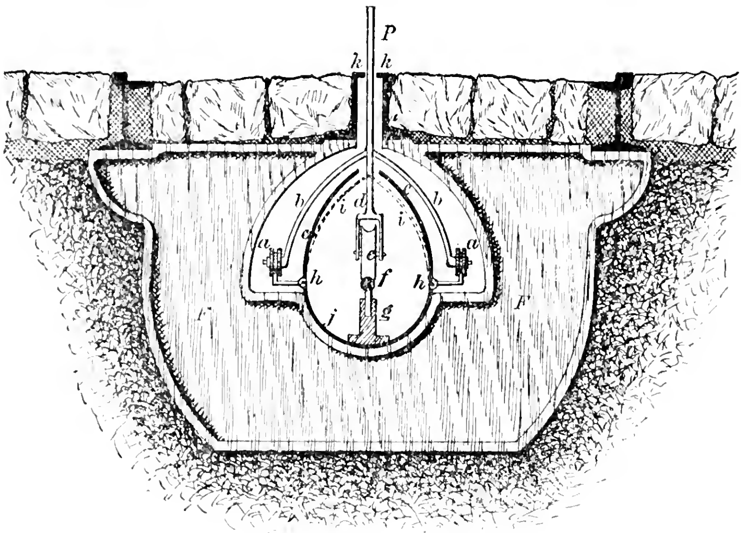


FIG. 25.—UNDERGROUND CONDUIT WITH PROTECTING SHIELD FOR THE CONDUCTOR.

Fig. 25 shows one of the forms of a class of underground conduits belonging to the inclosed conductor type. The track rails are supported upon the outer ends of large castings, *F F*, commonly called yokes. These are made of such size that the portion below the opening which incloses the conduit may be of sufficient depth to afford the requisite strength to properly support the track. The conductor that carries the current is located at *f* and is insulated from the casing *j*, which forms the lower half of the conduit, by the stands *g*. From the car a bar, *P*, which is called a plow, projects downward through the slot between the rails, *k k*, and on its end is spread out into a fork, *d*, which carries a pulley, *e*. When this pulley is in contact with the conductor *f* the current passes through the plow *P* to the motors upon the car, and thence to the track rails and back to the power house.

As the yokes *F F* and the conduit casing *j* are made of iron and are in metallic connection with the track rails, it is evident that if the conduits should fill with water to the depth of the wire *f* the current would pass directly to the rails, and thus would avoid the longer path through the motors. To prevent this occurrence, the sides of the conduit are inclosed with the sheet-iron covers *c c*, which nominally are in the position shown by the dotted lines *i i*.

The plow is also provided with the arms *b b*, upon the ends of which are mounted small wheels *a a*, and these run upon tracks attached to the covers *c c*. As is shown in the figure, the wheels *a a*, running upon the tracks attached to the covers *c c*, cause the latter to spread out to the position in which they are shown. This spreading, as can be readily understood, only takes place for a short distance ahead and behind the plow, but at all other parts of the conduit the sides assume the position *i i*, and thus close the conduit and exclude the water.

It can be easily seen that some difficulty would be encountered in making a tight joint at *h h*, and also that the opening and closing of the sides might not operate as perfectly in practice as upon paper, but it does not follow from these facts that the design is not practical; it simply illustrates that there are many minor difficulties to be overcome in order that complete success may be attained. Many designs operating upon this principle have been patented, and in some of them a great amount of ingenuity is displayed.

Fig. 26 illustrates another type of inclosed conductor which at a first glance appears to be far superior to that just described, but upon closer investigation it is found to be not wholly free from objections that are difficult to overcome. The yoke *F F*, as in the

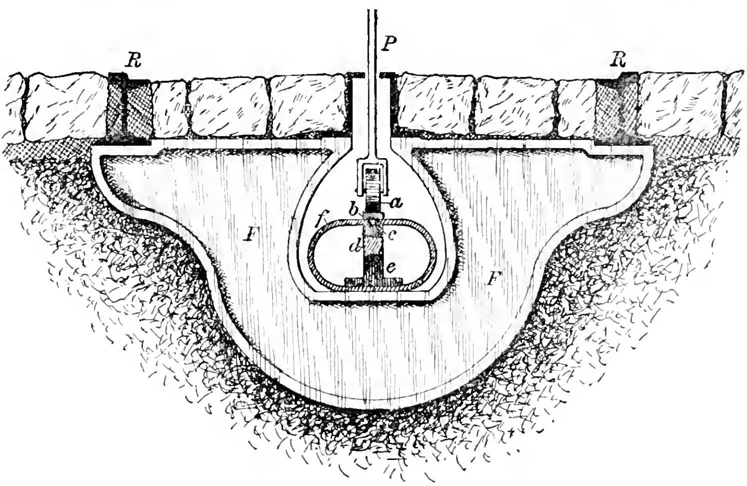


FIG. 26.—UNDERGROUND CONDUIT WITH INCLOSED CONDUCTOR.

design just described, is made wide enough to support upon its outer ends the track rails *R R*, and is cut away in the middle to an outline conforming with the shape of the conduit. The conductor that carries the current is located at *d*, being supported by the stands *e*. An elastic tube *f* is provided, which is water-tight and thus excludes moisture from its interior, within which the con-

ductor *d* is located. On the top of tube *f* a flexible rail *b* is secured, and this connects with studs *c*, which are within the tube, as clearly shown in the drawing, and so situated that they may be forced down into contact with *d*. Normally these studs are separated from *d*, but when the car comes along, the wheel *a*, mounted upon the end of plow *P*, flattens the tube *f* and thus forces one or more of the studs *c* into contact with *d*. The distance between the studs *c* is such that at least two will always be in contact with *d*, thus insuring a continuous electrical connection with the motors so long as the plow is depressed.

The first impression upon looking at this design would be that it is entirely free from objections; for if we assume that the tube *f* is made of rubber, we can see it in our mind's eye springing up after the plow passes by and thus separating the contacts *c* from *d*, and at the same time yielding freely to the pressure of the wheel *a*. All of this is true, but rubber is not very durable when under such exposed conditions, and to maintain a length of several miles of it in a perfect state for even two or three years could not reasonably be expected; and if it became necessary to renew the tube oftener than this the cost of maintenance would be entirely too great. There is another objection, however, which is more serious, and that is that the conduit will gradually fill up with dirt, and this pressing against the rubber tube would force it out of shape, and thus cause the contacts *c* to bear permanently upon *d*, or else to become so far displaced that they would not touch it when depressed by the plow.

As the rubber tube can not be depended upon, inventors have sought to improve the construction by using sheet steel and making the tube flatter and much wider, so that a section of it would present an outline much resembling an elliptic carriage spring. Such a construction will meet the requirements as to strength and the retention of the contacts *c* in their proper position; but steel expands when warm and contracts when cooled, therefore a long tube would be stretched so much in winter that it might pull apart, while in summer it would be compressed and tend to buckle up and thus be forced out of place. These difficulties can be overcome by providing expansion joints at suitable intervals, so that they are not necessarily proof of the impracticability of devices based upon the principles involved in this design; they simply serve to forcibly bring to mind the fact that the path of the inventor of underground systems is not strewn with roses, no matter in what direction he may turn to find a solution of the problem.

The object in the designs Figs. 25 and 26 is to shield the conductor so that it will remain dry should the conduit be filled or par-

tially filled with water. If water could be excluded from the conduit, the casing *j c c*, in the first figure, and the tube *f*, in the second one, would not be required, for there is no difficulty in providing an insulating support that will hold the conductor firmly in place and at the same time prevent the escape of the current; but as soon as moisture collects upon the surfaces of the insulating supports it acts as a conductor, and thus renders the insulation of little value.

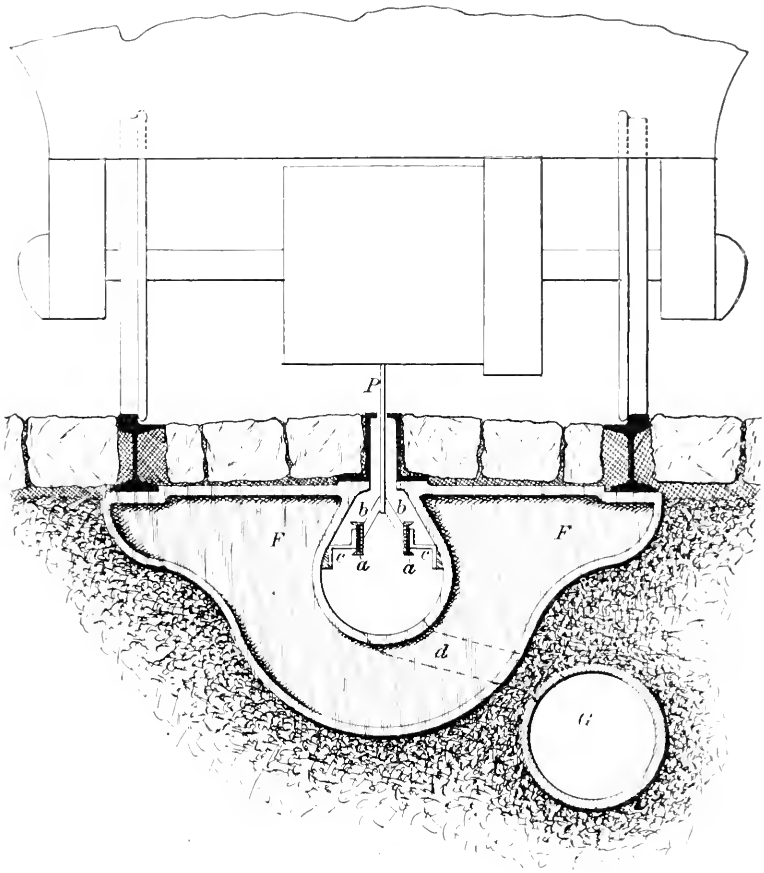


FIG. 27.—UNDERGROUND CONDUIT WITH EXPOSED CONDUCTORS.

If water runs into the conduit in such quantities as to come in contact with the conductor, then the effect of the insulation is entirely destroyed; the aim of the inventors, therefore, is to provide means for preventing the accumulation of water or moisture around the conducting wire. It can be readily seen that the shorter the conductor the easier it is to protect it, and this fact has given rise to the development of a great number of designs classified as sectional conductors. In these, two conductors are used, one of which

is continuous and so situated and insulated that it can not under any conditions be reached by either moisture or water. The other conductor is made in lengths that vary all the way from fifteen to two or three hundred feet. Normally, these short sections are not

Fig. 28.—View of Street Railway Lines in Washington operated by Underground Conductor of Type shown in Fig. 27.

connected with the circuit—they are dead, as it is called—but when the car comes along, the plow, by acting upon suitable mechanism, establishes a connection between the continuous conductor and the portion of the sectional conductor that is directly under it, and in this way the current passes to the car. As soon as the car passes beyond a section of the sectional conductor, the connection between it and the continuous wire is broken automatically. Some of these arrangements depend upon mechanical devices, such as levers that are struck by the plow and thereby move a switch that closes a connection between the section and the continuous conductor, but in most instances the switch is operated by a magnet, which may be carried by the car or may be arranged so as to be energized as the car approaches it. Designs of this last type come under the head of electrically operated sectional conductor systems. There are other arrangements in which a magnet carried by the car attracts iron levers suitably disposed along the conduit, and these levers close switches that connect the section of conductor under the car with the continuous one. As the levers are actuated by the magnet, they only hold the switch closed while the latter passes over

them; thus the electrical connection is made and broken as the car moves along.

Most of the designs in which sectional conductors are used can be placed much nearer to the surface of the street than the types illustrated in Figs. 25 and 26, and this is a decided advantage, as it greatly reduces the cost of construction. Any system that requires an underground conduit, with the yokes *F F* to support the track, can only be used by roads upon which the traffic is very great, for the cost of construction would be such as to prohibit its use under any other conditions, no matter how successful its operation might be. For small roads with moderate traffic the question of first cost is of paramount importance, and the only system that can offer a satisfactory solution of the problem for these is one that does not require an underground conduit.

Although many patents have been taken out for systems similar to those described in the foregoing, nothing has been done practically with any of them except in an experimental way. Some are in operation on small roads in out-of-the-way places, being intended principally to illustrate the practicability of the system and thus assist in promoting its introduction elsewhere, but the system that has been adopted in a commercial way is one in which no attempt is made to shield the conductor from moisture and water, and for its successful operation dependence is placed entirely upon the proper drainage of the conduit. This system is well illustrated in Fig. 27. The plow *P* carries upon its end two brushes, *b b*, which are insulated from each other. These brushes rub against the con-

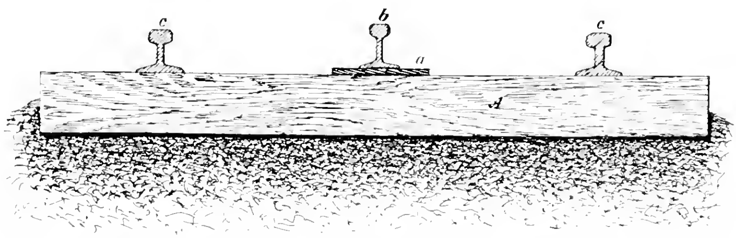


FIG. 29.—CROSS-SECTION OF RAILWAY TRACK PROVIDED WITH THIRD-RAIL CONDUCTOR.

ductors *a a*, which are made of bars of channel iron and are well insulated from the yokes *F F* and the conduit casing to which they are attached by means of the supports *c c*. In the construction shown in the figure the current comes from the generator through one of the *a* bars and returns through the other, but both bars can be used to conduct the current from the generator, in which case the return can be effected through the track rails, just as in the designs already considered. If both the bars *a a* are used to convey the current from the power house the insulation between

the brushes *b b* is not required. To avoid the accumulation of water in the conduit the drain *G* is provided with outlets *d*, located at suitable points.

Although this system is the simplest that can be devised for use in streets or public highways its construction is very costly, so much so that it can only be used in cities where the traffic is so great as to require the running of cars on short headway; and, furthermore, it can not be operated with any degree of success except in municipalities where there is a good sewage system. During the summer months it is liable to be more or less impaired by heavy showers, but the trouble in such cases is only temporary. In winter time snowstorms are liable to affect it in the same way, especially if, after a heavy fall, a warm wave comes along and produces a rapid thaw.

From the fact that no attempt whatever is made to protect the conductors, one would naturally suppose that every time there is a rain the road would be compelled to shut down; for, as the slot through which the plow travels is open, water can enter the conduit with the greatest freedom, and, in trickling down the sides, would be caught to some extent upon the brackets *c c*, and thus make its way over to the channel bars *a a*, and thereby destroy the insulation. Practice, however, shows that this action does not take place, at least not so often as to produce any serious trouble. The roads that are operated by electricity in New York, and also the lines of the Capital Traction Company, of Washington, D. C., employ this system, and they have been in operation a sufficient length of time to fully demonstrate that the difficulties actually developed by the action of the elements are not of a formidable character. On one occasion the Sixth Avenue road, in New York, was compelled to stop its cars for a short time just after a severe snowstorm, but the failure was not due to impairment of the insulation, according to the statements of the officials of the company, but to the fact that the melted snow froze upon the track and caused the wheels to slip around without sending the car ahead. The fact that other roads in New York, belonging to the same company, are being equipped with the system, is proof that, upon the whole, its practical operation is regarded as satisfactory; but it is very evident that it is not the final solution of the problem. A system to be a decided success must cost very little more than the ordinary overhead trolley, and its construction must be such that it will not easily get out of order. If it is not inexpensive it will not come into use except in places where the authorities will not permit the overhead wires. A surface or underground system ought to be more durable than the overhead, as the wires are not

liable to be injured by high winds or the accumulation of ice and snow; and, furthermore, as the conductors are below the ground the danger of burning out motors and generators by lightning would be eliminated, and this is a serious matter with all trolley roads, especially in cities. Country roads do not suffer so much from lightning, because when there is a heavy thunderstorm the generators are stopped and the trolley poles are pulled away from the wire, the cars remaining stalled on the track until the storm passes over. This course can not be pursued by city roads, for the passengers feel that, lightning or no lightning, they must reach their destination, therefore the cars must continue to run and take their chances.

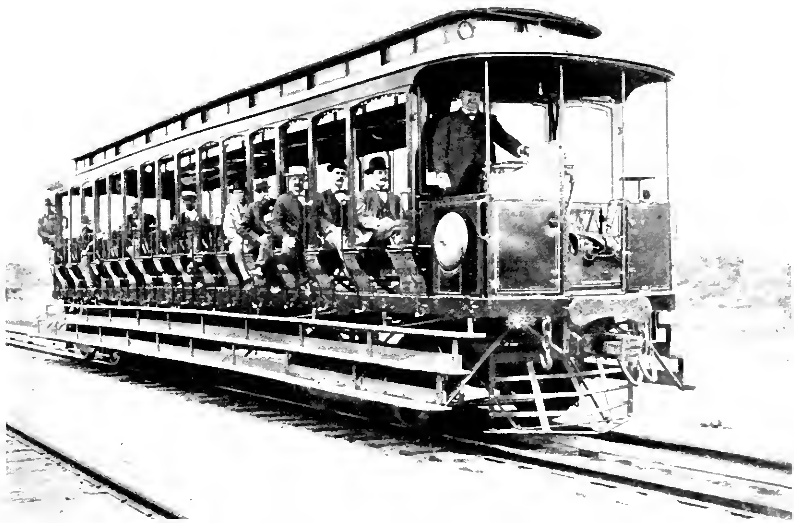


Fig. 30.—View of a Section of the New York, New Haven and Hartford Railroad, equipped with the Third-rail System.

Lightning, however, does not strike trolley lines as often in cities as in the open country, owing to the fact that there are so many iron buildings and roofs to attract it in other directions.

Fig. 28 shows the appearance of the street surface when an underground system such as is illustrated in Fig. 27 is used. This figure is a photograph of the Capital Traction Company's lines in Washington. After looking at this picture one can not deny that the appearance of the streets of a city is greatly improved when the overhead wires are removed, but underground systems which require a plow to run in a groove are not without objection, for the groove forms a dangerous trap into which the narrow-tired wheels of light wagons can readily drop, and the toes and heels of horse-

shoes can be caught. Thus, unless the slot can be dispensed with the greater beauty overhead is obtained at the expense of increased danger on the street surface. There are quite a number of underground conductor systems in which the slot is not used, the current being conveyed to the car by contact made with plates set at suitable intervals between or along the sides of the tracks, and on a level with the street surface. Many of these arrangements appear to be quite practical, but none of them can attract the attention of railroad managers unless it can be constructed at a reasonable cost.

About two years ago the New York, New Haven, and Hartford Railroad published a report of the performance of a branch line that was equipped with electric motors, the current being conveyed to them by means of a third rail. Some of the sensational dailies at once took the matter up and heralded the third rail to the public as something entirely new and sure to supersede the trolley. Now, as a matter of fact, the third rail is one of the oldest arrangements that have been used, and was in daily operation in Baltimore in 1886. It is a very cheap system and well adapted to roads owning the right of way or running upon elevated tracks, but could not be used on public highways or streets. The third-rail system in its simplest form is shown in Fig. 29, which represents a section through the roadbed. The log A represents a tie or sleeper, and c c are the track rails, while b is the third rail through which the current passes to the motors. Between the rail b and the tie A is placed a piece of insulating material, a, of such dimensions as may be necessary. If the track is high above the surrounding ground, so as to not be submerged when there is a heavy fall of rain, a may be thin, but otherwise it must be of sufficient thickness to raise the rail above the high-water mark. The car is provided with a wheel or brush to bear upon the rail b.

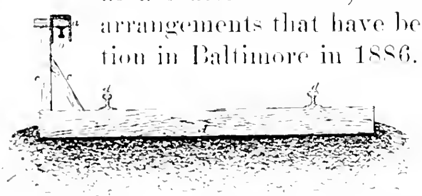


Fig. 31.—Cross-section of Railway Track, showing a Modification of the Third-rail System.

This is the construction used upon the New York, New Haven, and Hartford Railroad, as can be seen from Fig. 30, which is a photograph of a section of the road. The third rail, it will be seen, is raised but slightly from the ties, just about as shown in Fig. 29. One objection to this construction is that persons and animals can receive shocks by touching the center rail and one of the side ones at the same time, as, for example, by standing with one foot on each. Such shocks would not prove fatal to men, as the currents used for railway work are not of a sufficiently high

FIG. 32.—ELECTRIC LOCOMOTIVE ON THE BUFFALO AND LOCKPORT RAILWAY.

electro-motive force to produce death, but the shock is nevertheless very severe. Horses and cattle would be killed outright, as these animals are not able to withstand as strong a shock as human beings. To render the third-rail system safer, and also to improve the insulation of the conducting rail, the construction illustrated in Fig. 31 has been devised. The only difference between it and Fig. 29 is that the rail *b*, instead of resting upon the ties between the tracks, is carried upon a side support *c c* and is housed in with boards ***a a***. To take the current from it a wheel is mounted upon a shaft projecting from the side of the car truck.

From the foregoing brief description of the essential features of the several systems devised for conveying current to the moving car by means of conductors placed underground or upon the surface, it can be seen that while the result can be accomplished in many ways, and is actually accomplished in a number of instances, nothing has been brought forward so far that is as free from objection as the simple trolley, if we disregard the unsightliness of the latter. It is this unsightliness that has created a demand for something else, but the substitutes, while capable of doing the work, are far more costly and can not be said to be as reliable under all conditions of weather.

The sphere of action of the electric-railway motor is not confined to street railways or suburban transit, but extends to the legitimate domain of the steam locomotive. In many places electric locomotives are used to move freight trains made up of cars of the largest capacity, this same work having been done formerly by steam locomotives. In the city of Baltimore, the Baltimore and Ohio Railroad uses electric locomotives, of greater capacity than any steam locomotives so far made, to draw trains through the tunnel that passes under the city. The general appearance of an electric locomotive can be judged from Fig. 32, which shows an engine of average size at the head of a long freight train.

MM. Bertaux and G. Yver are quoted, in *La Nature*, as relating in their travels in Italy that between Benevento and Foggia, where the railway passes through a tract of wheat fields, a falcon was observed closely accompanying the train. He would graze the windows, fly over the roofs of the cars and turn, and keep constantly dashing down to the ground by the side of the track. A habitual traveler on the road remarked that he had observed this habit of the bird several times a week. The crafty hawk had observed that the eddy made by the train as it rushed through the air overcame the small birds and made them an easy prey, and it had learned to take advantage of the fact. It was also remarked that this particular train, which was the "fast train," was the only one the bird thus pursued.

A SURVIVAL OF MEDIÆVAL CREDULITY.

By Professor E. P. EVANS.

ONE of the crassest and most impudent and yet most successful frauds of modern times is that recently practiced by Leo Taxil and his associates on the papal hierarchy in their pretended exposures of the Freemasons and the Satanic rites performed by this secret fraternity. On April 20, 1884, Leo XIII issued an encyclical letter in which he divides the human race "into two diverse and adverse classes" (*in partes duas diversas adversasque*): "the kingdom of God on earth—namely, the true Church of Jesus Christ"—and "the realm of Satan." All who are not members of the former belong to the latter, so that there is no alternative between being a good Catholic or a worshiper of the devil. His Holiness then proceeds to show that the headquarters of Satanism are the lodges of the Freemasons, a fact, he adds, fully recognized by his predecessors, who have never ceased to expose and denounce the diabolical character and flagitious aims of these archenemies of the Christian faith. The detailed description of the organization of this order, its devilish purposes, and the horrible crimes committed in order to accomplish them are very queer reading in an official document emanating from an infallible ecclesiastical authority at the close of the nineteenth century. On August 20, 1894, Leo XIII published a decree of the Inquisition putting under ban "Odd Fellows, Sons of Temperance, and Knights of Pythias" as "synagogues of Satan," and excluding them from the sacraments of the Church.

It is no wonder that such an exhibition of credulity, which excited the astonishment of many a Romanist and made all intelligent and unprejudiced persons smile and shrug their shoulders, should have suggested to an arrant wag and incorrigible player of practical jokes like Leo Taxil (pseudonym of Gabriel Jogand) the idea of appealing to this peculiar passion on a grand scale and seeing to what extent the "mother Church" could be led into fraud, as Milton says, like "Eve, our credulous mother." In tracing the development of this audacious plot through all its stages and perceiving by what silly tales and transparent deceptions the Holy Father permitted himself to be duped, one can hardly refrain from exclaiming, in the words of Ben Jonson:

> "Had you no quirk
> To avoid gullage, sir, by such a creature?"

Leo Taxil was born at Marseilles on March 21, 1854, and was therefore thirty years of age when he entered upon this career of

intrigue and mystification. From his childhood he had been educated in strictly Roman Catholic schools, and everything was done by his pious parents and teachers to render him sound in the faith. Long before arriving at man's estate he had thrown off these influences and cast in his lot with unbelievers, although he continued to go to mass, confession, and communion. While a pupil in the Catholic College of St. Louis, at Marseilles, he was strongly attracted to the political views of the radical party as set forth in Rochefort's *Lanterne*, and soon began to write for the press; in 1871 he joined the editorial staff of *Egalité*, and published for two years a humoristic journal—*La Marotte* (Fool's Bauble). It is not necessary to give a detailed sketch of this man's life. Suffice it to say that he was violently anticlerical, and was repeatedly fined and imprisoned for articles insulting to the Church and to ecclesiastical dignitaries. On December 29, 1881, at Montpellier, he was condemned to pay a fine of sixty-five thousand francs for publishing a book entitled The Secret Amours of Pius IX. He appealed from this decision, and, after repeated efforts, succeeded in having the indictment quashed. A new edition appeared in 1885, and was announced by large placards, in the center of which was a medallion of the Pope's head, encircled with the heads of a bevy of beautiful women, forming, according to the author, a fitting halo for his Holiness. We may add that the sensational revelations contained in this book, as well as in the Scandalous History of the Orléans and similar works, are for the most part mere figments of the imagination recorded as facts, for the purpose of mystifying a credulous public. In 1880 he founded a "Society of Freethinkers," which, with its numerous branches, numbered in a few years about seventeen thousand members. The remarkable success of this movement was due in a great measure to the energy with which he advocated it in the columns of the *République Anti-Clericale*, of which he was the editor.

Perhaps the most comical episode in his strange career is his pretended repentance, resulting in the return of this black sheep to the fold of the Catholic Church. In his Confessions the arrant renegade relates how, on April 3, 1885 (April 1st would have been a more appropriate date), while engaged in writing a book on Joan of Arc designed to excite animosity against the clergy, his fell purpose was suddenly shaken by strong compunctions, and soon a fearful agitation convulsed his whole being. His description of his contrition and self-reproaches is quite sensational and thrilling, and shows rare talent as an actor, if we only bear in mind that the whole thing was a farce. "I burst into sobs. 'Pardon me, O God!' I cried out in a voice choked with tears. 'Pardon

my many blasphemies! Pardon all the evil I have wrought!' I passed the night in prayer, and resolved on the next day to seek absolution for my sins." He retired from the editorship of the *République Anti-Clericale*, and handed in his resignation at a meeting of the "Anti-Clerical League," of which he was the founder and hitherto the most active member, when he had the satisfaction of being denounced by the presiding officer as a comedian and scoundrel. No one of his former colleagues believed in his sincerity, and yet every one was puzzled to understand the strategic purpose of this retrograde movement. The general impression was that he had been bribed. "You can't fool us by your abjuration!" they exclaimed. "The fact is, you have received a large sum of money from the Vatican." He does not seem to have attempted to refute these charges, nor did he permit them to divert him from the execution of his deep-laid plot. With hypocritical humility, he made full confession to the papal nuncio in Paris, Monsignore Di Rende, who, after subjecting him to several days' penance, embraced him with joy and released him from all excommunications and ecclesiastical censures.

Taxil now began to issue his Complete Revelations concerning Freemasonry, in four volumes, the ostensible object of which was to expose the secret and sacrilegious rites of this order as an organized system of devil-worship, thus confirming by the testimony of an eyewitness the assertions of the Popes, and proving that their decrees and decisions on this point had been bulls in the ecclesiastical and not in the Irish sense of the term. This work, although a mere tissue of fabrications, was greeted by the Catholic press and priesthood with exultation, as an authentic narration containing positive and irrefutable proofs of the diabolic character of the Masonic mysteries. The members of this fraternity, says Taxil, regard the God of the Catholics as an evil principle—a crafty, jealous, and cruel genius, a supernal tyrant, and archenemy of human happiness. Opposed to him is Lucifer, the good genius, the perennial source of virtue and wisdom, the spirit of freedom, and the friend of mankind. For this reason, in the high-grade lodges Lucifer, the reputed father of Cain, Canaan, and Hiram, is adored, under different names indicative of the Supreme Being, as the God of Nature, and the great architect of the universe. In short, while modern freethinking is atheistic and begets a skepticism which, even when not denying God, does not care for him, Freemasonry is essentially a Satanic cult. These words give the sum and substance of the supposititious disclosures which excited such intense joy in the clerical camp. In 1887, when Taxil was received in solemn audience by Leo XIII, "My son," asked the Pope, "what dost thou

desire?" "Holy Father, to die this moment at thy feet were for me the highest bliss," replied the kneeling penitent. "Not so," was the benignant response of the successor of St. Peter; "thy life is still very useful in combats for the faith." His Holiness then pointed to Taxil's writings on the shelves of his library, declaring that he had read them all through with extreme satisfaction, and encouraged him to continue his exposures of these satellites of Satan and their abominations. Taxil left the Vatican with the papal benediction and with the firm conviction that he could devise no better means of currying favor with the Apostolic See than by inventing tales about the homage paid by the Freemasons to the devil, and determined to work this rich vein to its utmost capacity. He also came to the conclusion that he could imagine nothing so absurd that it would not be received in Catholic circles as authentic and indorsed by infallible authority.

His work had an immense pecuniary success, and thus attained the chief object which he had in view. More than one hundred thousand copies of the original French edition were sold, and it was translated into English, German, Italian, and Spanish. This result is not so surprising, if we remember that nearly all the bishops and other clergy of the Catholic Church acted as voluntary and extremely zealous agents for the diffusion of these Revelations, which they seemed to regard as a new apocalypse designed to unveil the mysteries of Babylon and disclose the present doings of Satan and dominion of antichrist. Of the utterly apocryphal character of the Revelations they do not appear to have entertained the slightest suspicion, although the hoax was clearly perceptible to every unprejudiced mind. The German translation by the Jesuit Father Gruber, which appeared at Freiburg, in Switzerland, and at Paderborn, in Westphalia, omitted the volume entitled The Masonic Sisters, on account of the indecency of its contents, although accepted as true and deemed especially damaging to the Masonic fraternity. However desirable it might be to tear away the mask of philanthropy from the face of Freemasonry and let the world see its devilish features, it was thought best not to outrage the moral sense of the community by uncovering "the filthiness of the hellish crew."

In 1892 Taxil's coadjutor, Dr. Bataille (a pseudonym of Dr. Karl Hacks, a German from the Rhineland), began to issue a serial publication, entitled The Devil in the Nineteenth Century, purporting to embody the results of his observations as ship's surgeon during his travels in various countries, and especially in the Orient, where he had opportunities of studying Satanism in its diverse manifestations. He begins by referring to the encyclical letter

Humanum genus, already cited, in which Leo XIII divides the human race into worshipers of God and worshipers of Satan, and then proceeds to adduce facts proving the correctness of this classification. It is, in reality, a bold burlesque of the papal circular, as, indeed, it was intended to be, and would doubtless have been laughed at for a time as a clever persiflage, if the dignitaries of the Church had not taken it seriously, as they were expected to do. Dr. Hacks confessed to an "interviewer," in 1897, that no sooner had he read the pontifical circular in question than he saw in it "a rare opportunity to coin money out of the crass credulity and boundless stupidity of the Catholics. It needed only a Jules Verne to clothe these extravagant fancies in an attractive garb. I resolved to play the part of this Jules Verne. Strangely enough, the same idea occurred to others. I therefore joined forces with Leo Taxil and a few friends, and began to publish The Devil in the Nineteenth Century, the success of which is well known. . . . I had traversed many lands and got up marvelous stories, the scenes of which were laid in remote regions, which I was sure no one would visit in order to test the truth of my assertions." Besides, he counted on the silliness of the persons with whom he had to deal, and felt certain that if he should tell them he had been fooling them they would not believe him, but would remain convinced that all his inventions were strictly true. He could not conceive of a body of ecclesiastics as ready to discard a belief which served their turn, however evident its absurdity might be to other minds. "Sometimes I fabricated the most incredible stories, as, for example, that of the serpent inditing prophecies with its tail on the back of Sophia Walder, or that of the demon, who, in order to marry a Freemason, transformed himself into a young lady, and played the piano evenings in the form of a crocodile. My colleagues were aghast, and exclaimed, 'You'll spoil the whole joke with your nonsense.' 'Bah!' I replied. 'Let me be, and you will see!'" And they did see how eagerly such gross falsehoods were accepted as positive facts. Protestants without exception are denounced as godless apostates. Every Lutheran is a Luciferian in disguise. Singapore, he says, like every British colony, is settled by knaves, footpads, and all sorts of criminals. The Protestant Englishman is, at the bottom, an embodiment of scoundrelism coupled with Satanism. There is a strangely infernal element in the social life at Singapore. "The British matrons and even the maidens are incarnations of vice and godlessness. The young English woman dedicates all her charms and intelligence to the service of Satan, whose apostle and agent she is; cursed by God, she is the dearly beloved paramour of Lucifer; a woman only in name,

she is in fact absolutely infernal—an actual deviless." Hacks asserts that in a Presbyterian church at Singapore he discovered a secret tabernacle for the worship of Satan. The pastor opened the door, and there was a Baphomet, with all the Palladistic (Satanic) apparatus—goblet, host, and dagger—standing before his eyes.

Albert Pike, Grand Master of the Freemasons in Charleston, S. C., is called the "Satanic Pope," and is said to have a telephone invented and operated by devils, whereby instantaneous communication is possible between the seven principal directorates at Charleston, Rome, Berlin, Washington, Montevideo, Naples, and Calcutta. He has also a magic bracelet, by means of which he can summon Lucifer at any moment. "One day Satan took Pike gently in his arms and made a trip with him to Sirius, traversing the whole distance in a few minutes. After exploring the fixed star, he was brought back safe and sound to his room in Washington." Whether he found the star as hot and scorching as its name implies is not stated. Hacks discovered, under the cliffs of Gibraltar, mysterious caverns with laboratories in which devils prepared microbes for generating and diffusing epidemics. He was politely received by Tubal-Cain, the director of the establishment, who addressed him in pure Parisian French, from which we may infer that this is the language of the lower regions. On his departure Hacks was presented with a small vial, the contents of which would suffice to produce a fearful epidemic of cholera. No less an authority than Professor Bautz, of the Prussian Academy at Münster, tells us that the volcanoes are the flues of hell, and it was probably this contribution to the topography of Tartarus that led Hacks to look for the devil's workshop in the cavities of mountains, which, however, being used for infernal purposes, would hardly be what Milton calls "umbrageous grots and caves of cool recess." *

The following may be cited as a specimen of the manner in which historical events were perverted by Hacks to subserve his purpose: Before the capture of Rome by the Italian troops in 1870, a secret meeting of Freemasons was held in Milan, at which Riboli, Cucchi, and General Cadorna were present, and the revolution-

* Views similar to those of Professor Bautz have been advocated by a French Jesuit, Père F. H. Schouppe, in a work entitled The Doctrine of Purgatory elucidated by Facts and Private Revelations. The "facts" consist of the visions of saints, and the "private revelations" prove to be apparitions of souls in purgatory to hysterical women and other persons "blasted with ecstasy." The book has been translated into German by a Tyrolese priest, G. Pletl, and just published at Brixen, "with the approbation of the Prince Bishop." An Austrian journal, the Ostdeutsche Rundschau, printed extracts from the volume with appropriate comments, and was confiscated by the Government in Vienna for "offense to religion."

ary deliberations were rendered piquant by dreadful blasphemies. Thus General Cadorna, a renegade priest, parodied the consecration of the host with a piece of bread, which he finally threw into the fire with the words, "In honor of Lucifer!" Thereupon Lucifer rose up in person through the floor, gazed benignantly for a moment on his faithful followers, and said, "The moment is come for firing the third salvo of cannon." A month later General Cadorna entered Rome through the breach of the Porta Via. In Luciferian lingo, the first salvo was the Reformation and the second the French Revolution, while the third victory of Satan was the overthrow of the Pope's temporal power.

Hacks relates that in Freiburg, Switzerland, there was a Masonic temple of Satan hewn in a rock and provided with altars and all the paraphernalia of this cult. There men and women assembled in the costume worn by our first parents before the fall. Attached to the lodge was a brothel, the scene of the most disgusting debaucheries. One altar, in the form of a triangle with an image of the demon Baphomet, was used for stabbing the body of Christ, in the form of consecrated wafers, with a dagger. At this altar, too, was said the so-called "black mass," an invention of the Grand Master Holebrook and Albert Pike, of Charleston. During this service hymns were sung to Satan. The consecrated wafers were procured by Miss Lucia Claraz, of Freiburg, who stole them while pretending to partake of the communion, and passed the night before committing the theft in the wildest orgies. This incredibly foolish story was published in the *Moniteur de Rome*, against which Miss Claraz, a lady "piously inclined and morally irreproachable," according to the testimony of the Bishop of Freiburg, brought suit for defamation. The court sentenced the editor, Monsignore Vöglin, to a fine of twenty-five thousand lire and four years' imprisonment.

These examples suffice to show the wretched stuff which Hacks hashed up for the edification of the clerical and the entertainment of the carnal-minded public. Even the silly statement that he saw a gigantic tree bow down before Sophia Walder, the predestined great-grandmother of antichrist, and present her with a bouquet, did not shake the faith of the true believers. The editor of the *Revue Mensuelle* declared, in 1894, that Dr. Bataille had really made all these discoveries on his travels, and that his honesty and sincerity were beyond question. This was the attitude of the whole clerical press almost without exception, as well as of abbots, bishops, cardinals, and the highest dignitaries of the Church. Even as late as July, 1897, when the imposture had been exposed and confessed, a Parisian Catholic journal continued to regard "the mys-

tification as more apparent than actual, and the documents adduced as chiefly authentic"; so difficult is it for minds thus constituted, with the rational faculties dwarfed and stunted by being constantly kept in the leading strings of credulity, to recognize the falsity of what they wish or are told to believe.

Another of Taxil's confederates was Domenico Margiotta, according to his own account a native of Palmi, in southern Italy, and professor of literature and philosophy. His principal work, Adriano Lemmi, Supreme Head of the Freemasons, published in French in 1894, gives a long list of his titles, designed to impress the public by indicating his high position in the Masonic order. Hacks calls him a "Member of the Sovereign Sanctuary of the Oriental Rite of Memphis and Mizraim," a purely fictitious designation. This cunning device was also crowned with complete success, and caused the fabricated disclosures to be hailed with enthusiasm. Here, exclaimed the clerical journals, we have "not an apprentice or novice like Taxil, but one of the highest dignitaries of universal Freemasonry and Luciferianism, who is initiated and instructed in all its mysteries and occult observances," being apparently ignorant of the fact that Taxil was in the main the real author of the book.

One of the most common accusations brought against the Freemasons is that of desecrating the host by stabbing it with a dagger. A German Catholic journal, The Pelican,* affirms that not only Masonic devil worshipers, but also Jews, infidels, and heretics in general commit this sacrilege in order to show their deadly hatred of Christianity. In proof of this charge, the following "historical fact" is published in the number for July, 1897: Several consecrated wafers were once stolen by Jews from a church at Langenses, in Silesia, and, after being pierced through with knives, were hidden in the forest. They were discovered by a Polish nobleman, whose four horses, as he was driving by, suddenly kneeled down and refused to go on, although he beat them

* The manner in which The Pelican makes piety profitable is most extraordinary and should win the admiration and excite the envy of the "yellow press." The editor informs the public that he entered into a compact with St. Joseph, promising to distribute fifty books in which this holy person is glorified, provided the journal receives two thousand subscribers. In less than a year the number of subscribers was twenty-five hundred. A promise to distribute one hundred books of this kind, if St. Joseph would procure eight thousand subscribers, raised the list of subscribers to twelve thousand; and this barter went on until The Pelican could boast of ninety thousand subscribers. The editor also announces that he has engaged two hundred and eighty priests to say masses for the readers of his paper and to pray for and bless their children, and concludes this astounding piece of puffery as follows: "Experience teaches us that the benediction of a single priest is effective. What, then, can not be obtained if two hundred and eighty priests unite in blessing us!"

with his whip. He then descended from the carriage, and soon found the wafers covered with blood. They were carried back with solemn ceremony to the church, which became a place of pilgrimage with a wonder-working pyx. What a hardened and hopeless skeptic a man must be, who is not convinced by conclusive evidence of this kind, when even horses bear witness to the truth by their genuflections!

Still more sensational was the part played in this spicy comedy by Miss Diana Vaughan, whom Taxil introduced to the public as a descendant of the Rosicrucian alchemist and Oxford professor Thomas Vaughan, and who was said to have in her possession a copy of the written pact with Satan, signed by her ancestor on March 25, 1645. The young lady claimed to have been born in Paris on February 29, 1874. The fact that there was no February 29th in the year 1874 would make this date an impossible natal day for ordinary mortals, but a person with Luciferian blood in her veins would naturally take no note of the divisions of time as recorded in human calendars; for, according to Taxil, her forbear was the goddess Astarte, who appeared to Thomas Vaughan on a summer night in 1646, while he was sojourning among the American Indians, in all her marvelous beauty, bringing with her a bed surrounded with flames and attended by little demons bearing flowers. She approached Vaughan and put a wedding ring on his finger, and eleven days later gave birth to a daughter named Diana, from whom the Miss Diana Vaughan in question traced her descent. Several instances of similar commerce with incarnate demons are said to have occurred in the history of her family, so that she inherited a strong Satanic taint; even her own mother was guilty of the same criminal conduct. Her inherited qualities were carefully fostered by education, inasmuch as she was brought up by her father and uncle on strictly Luciferian principles. One day, when her instructors were praising Cain and Judas as ideals of excellence, she expressed some doubt of the superior worthiness of the fratricide and venal traitor. This dangerous unbelief was attributed to angelical possession, and it was soon ascertained that the archangel Raphael was the cause of the lapse from Luciferianism. Recourse was had to exorcism, the whole process of which, as described by Taxil, is a clever travesty of the ceremonial prescribed by the Romish Church for the expulsion of evil spirits. The dance performed by the father and uncle on this occasion consisted of the same saltatory movements that are executed by the "procession of jumpers" every year at the grave of St. Willibord, in Echternach, Luxemburg.* Devil's ointment took the place of holy oil, and the

* *Cf.* Popular Science Monthly, November, 1895, p. 83.

exorcism ended with the sacrifice of a black hen; thereupon "Raphael" went out of her, and simultaneously with his exit all the panes of glass in the house were broken into fragments and fell to the ground with a tremendous crash. The marvel is that bishops and priests accepted this ridiculous story as an authentic and edifying narration, instead of rejecting it with horror and disgust as a palpable burlesque of their own approved methods of casting out demons, and particularly of the *Exorcismus in Satanam et Angelos Apostatas*, composed by Leo XIII and issued by him November 19, 1890. It is evident that Taxil had this document in his eye, and intended to hold it up to derision; to calm the fears of the simple-minded, who were puzzled and perplexed by the striking resemblance of diabolic orgies to divine ordinances, he explained it on the general principle that "Satan is the ape of God."

After being freed from the influence of Raphael, Diana was placed under the tutelage of Asmodeus, who, as her guardian devil, watched over her, shielding her from bodily harm and helping her to resist the wiles of angels. One day when she was wandering in the woods she was attacked by negroes, but Asmodeus came to her rescue, and bore her safely to her home through the air. Another time he caught her mettlesome courser by the bridle as he was running away, and when the chief of Garibaldi's staff, Bordone, insulted her, Asmodeus twisted his neck so that his face looked backward. For three weeks he was obliged to take a retrospective view of life and of his own conduct, when Diana, in the kindness of her heart, set his head right again. On these occasions the tutelar demon usually appeared in the form of a fine young gentleman, and emitted an aroma of balsam, which seems to have been as inseparable from him as is the scent of musk from a modern dude or modish dame. He spoke of her as his bride, and often took her on pleasure trips to paradise, purgatory, and other remote regions; once when she was greatly depressed, because her Luciferian rival, Sophia Walder, had got the better of her, he consoled her by making an excursion with her to Mars, where they rode on Schiaparelli's canals, sailed on the Sea of the Sirens, and strolled like pygmies among the gigantic inhabitants of that planet.

[*To be concluded.*]

CONTRARY to the common supposition that the astronomy of the ancients was based exclusively on the geocentric hypothesis, Mr. G. H. Bryan says in Nature: "Schiaparelli has shown that Heraclitus Ponticus, a disciple of Plato, had already accepted the theory that the sun is the center of the orbit of the planets, while the earth is the center of the universe and of the lunar and solar rotations—a theory substantially that of Tycho."

"RIBBON LIGHTNING."

By ORANGE COOK.

IN the summer of 1898, W. H. Osborne, of Chardon, Ohio, an amateur photographer of some experience, secured the accompanying photograph of a lightning flash which seemed to us to show certain peculiarities that entitle it to a public notice and a permanent record. The picture shows three flashes, of which the distant and faint one at the right and the bright one at the left were simultaneous, while the center one occurred a few seconds earlier. Nothing about the thunder that followed the last and bright flash suggested that it was specially near, but an examination of the picture when developed and a comparison with the features of the landscape showed that it had come to earth about fifteen rods from the place where Mr. Osborne stood with his camera. Mr. Osborne

and myself carefully searched the locality indicated, but failed to find even the slightest mark caused by the discharge upon any object or in the earth.

Measurements at this place give the width of the ribbon of light, if it stood at right angles with the line of sight, about eight feet. This ribbon of light is seen to consist of six lines, approximately parallel, of unequal brightness, a pair being at each edge and a pair near the center. The space between these pairs is crossed by many nearly horizontal lines and a few oblique ones, while that between the right-hand pair is crossed by oblique lines only. The horizontal lines at the right of the center become curved downward, which, with the increased brightness of the whole toward that side, suggests to us that the ribbon of light did not

lie in a plane, but was concave toward a point at the observer's left. That the ribbon did not stand at right angles with the line of sight, but was nearer the observer at the right-hand edge, is also shown by the inequality of the lower termination of the six vertical lines referred to above. The ones at the left either rest upon or are hidden behind a rise of ground, whose crest can be traced for a little distance each side of the flash, while those at the right come lower, falling between the observer and the ground at that point. Probably, when measured upon this diagonal and curved line, the width of the flash was fifteen or twenty feet.

Mention has already been made of the fact that the accompanying thunder was comparatively light, and not at all like that ordinarily heard when lightning occurs within so short a distance. Possibly this, as well as the absence of marks at the point where it reached the earth, might have been because the discharge was of very low tension.

[A very similar lightning flash was described and pictured in the issue of the Electrical World and Engineer for October 28, 1899, by A. E. Kennelly, who suggested the following explanation: A lightning flash passed through the air on the left-hand side of the ribbon of lightning (the wind was blowing from right to left) and broke a hole in the air along that line. This discharge may have been oscillatory, and may have lasted in all any time up to about $\frac{1}{100}$ of a second. The discharge then ceased for lack of electricity, but a fresh charge from the cloud being gathered immediately afterward, or in about $\frac{1}{30}$ of a second from the first rupture, a new discharge passed through the same hole in the air, which had not had time to seal up. There might thus be fourteen successive flashes (this was the number of distinct flashes making up the ribbon in the photograph), each averaging about $\frac{1}{25}$ of a second apart, through the same hole, owing to the imperfect conducting qualities of the clouds overhead, meanwhile the hole having been carried from left to right in the picture, across the line of sight (by the wind), and thus producing the appearance of a broad ribbonlike flash. Professor Trowbridge, of Cambridge, has suggested the possibility that many of these apparently curious electrical phenomena may be of purely optical or physiological origin—that is, may arise through the abnormal behavior of the eye or the camera lens toward intense lines of light, such as lightning flashes.—Ed.]

CROSS-EDUCATION.

By E. W. SCRIPTURE.
DIRECTOR OF THE PSYCHOLOGICAL LABORATORY, YALE UNIVERSITY.

SOME years ago I made the following simple experiment: I arranged a rubber bulb, like that used for releasing a photographer's shutter, to connect with a bottle, from which rose a long, vertical glass tube. The bottle contained mercury, and the long tube reached nearly to the bottom. Every part was air-tight, so that when anybody squeezed the bulb the mercury was forced up the vertical tube. It was what is known as a mercury-dynamometer.

During experiments with this dynamometer, what was more natural than to think of trying what would happen if one hand were practiced daily in squeezing the bulb? So one of our graduate students, Miss E. M. Brown, was set to work in the following manner: On the first day she squeezed the bulb as hard as possible with the left hand, while an assistant noted the height of the mercury; this was repeated ten times, and the results were averaged. Immediately thereafter she took ten records with the right hand. Then, on the following days, with some intermissions, she practiced the right hand by squeezing ten times on each occasion. On the last day she again tested the left hand, which had not been practiced in the meantime. The records ran as follows:

	DAY.								
	First.	Second.	Third.	Fourth	Fifth.	Sixth.	Seventh	Eighth.	Ninth.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Right hand	28.8	33.7	35.6	36.6	40.9	44.7	47.0	48.8	48.6
Left hand	29.6	....	....	....	....	....	....	....	42.3

Thus the left hand had gained about fifty per cent in strength through practice of the right hand. This peculiar phenomenon of transference of the effects of practice from one side to the other I have ventured to call "cross-education."

The phenomenon was curious enough to suggest other experiments. Another student, Miss T. L. Smith, was set to trying to insert the point of a needle at the end of a rod into a small hole in a drill-gauge without touching the sides. The first experiment consisted of twenty trials with the left hand, with a success of fifty per cent. Immediately thereafter twenty trials were made with the right hand, with a success of sixty per cent. On the following day and on each succeeding day two hundred experiments were made with the right hand, with successes of 61, 64, 65, 75, 74, 75,

82, 79, 78, and 88 per cent. On the last day the left hand, which had not been practiced in the meantime, was again tried, with a success of seventy-six per cent.

These last experiments remind us of certain familiar phenomena. It has frequently been noticed that persons taught to write with the right hand become able to write backward, but not forward, with the left hand. This is the so-called "mirror writing," which appears correct if seen in a mirror. The first published observation of this fact exists in a letter from H. F. Weber to Fechner, the founder of experimental psychology. Fechner, moreover, noticed that with the left hand he could make the figure 9 backward better than in the regular way.

Curiously enough, the principle of cross-education has been put to practical use. A letter (with permission to publish) has been received from Oscar Raif, Professor of Music in the Berlin Hochschule:

"In the spring of 1898 I made an experiment with twenty of my pupils. I began by taking the average speed of each hand with the metronome. The average of the right hand was ♩ = 116 (= four times 116 in the minute) [464 beats], and for the left hand 112 [448 beats]. I gave them exercises for the right hand only (finger exercises, scales, and broken accords) to develop rapidity. After one week the average of the right hand was 120 [480]; after two weeks, 126 [504]; three weeks, 132 [528], etc. After two months the right hand yielded 176 [604]. Then I had them try the left hand, which averaged 152 [608], whereas in November the average was only 112 [448]. In two months' time, absolutely without practice, the left hand had risen from 112 [448] to 152 [608]. A few of my pupils had some difficulty in playing the scales in parallel motion, but were able to play them in contrary motion.

"The tenor of my work is that in piano playing the chief requirement is *not* that each single finger should move rapidly, but that each movement should come at exactly the right time, and we do not work only to get limber fingers, but, more than that, to get perfect control over each finger. The source of what in German is called *Fingerfertigkeit* is the center of our nervous system—the brain."

These facts, however, require further investigation, for it is evident that we must begin with the fact of cross-education and proceed to more complicated cases. Indeed, cross-education has shown itself to be one step of a ladder up which we must climb even if there were no other motive except that of curiosity as to what we could find at the top. If practice of one hand educates the other hand, will it not also educate the foot? Again, if practice of one

hand in squeezing a dynamometer develops the strength of the other members of the body, will it not also develop their dexterity or their advance? Again, if the development of voluntary power —let us say, frankly, "will power"—in one direction brings about a development in other directions, why should we limit the transference to muscular activity? Why can we not expect that the development should be extended to the higher forms of will power that go to make up character? The outlook begins to be stirring on account of its vastness. If the last principle be admitted, there seems no argument against the claim that some forms of manual training, such as lathe work and forge work, are just the things to develop moral character. By the same reasoning we would be obliged to admit the often-made argument that training in Latin, Greek, and mathematics furnishes a means of general mental development. If we admit the principle, we find ourselves at once involved in important educational controversies. However we may think in respect to these questions, it is plain that it is worth while to climb a ladder which has such an outlook at the top. Let us begin.

In the first place, the fact of cross-education is established. Let us ask in what this education consists. On this point some curious observations have been made by Prof. W. W. Davis,* now of Iowa College. The subject of the experiment began by raising a five-pound dumb-bell by flexing the arm at the elbow; this called into play chiefly the biceps muscle for lifting and the forearm muscles for grasping. This was done as many times as possible with the right arm, and then, after a rest, with the left arm. The subject then entered upon a practice extending from two to four weeks; this consisted in lifting the weight with the right arm only. At the end both arms were tested as at the start.

The results were strange enough. The unpracticed left arm gained in power as we expected, but it also gained in size. Careful measurements were made by Dr. J. W. Seaver, of the Yale Gymnasium, on the girths of both upper arm and forearm. Let us compare the gains in girth with the gains in power:

Subject.	Gains in girth.		Gains in power.	
	Right biceps.	Left biceps.	Right arm.	Left arm.
G.	5 mm.	−5 mm.	820 flexions.	200 flexions.
J.	2 "	0 "	400 "	225 "
K.	4 "	2 "	724 "	514 "
H.	13 "	6 "	950 "	30 "
B.	6 "	11 "	900 "	75 "
I.	8 "	3 "	750 "	75 "

* Studies from the Yale Psychological Laboratory, vol. vi.

All subjects had gained power in the unpracticed left arm, three of them largely and three slightly. All but one had gained in the size of the unpracticed left biceps. Strangely enough, those who had gained most in power had gained least in size. The case was quite similar in regard to the girth of the forearm. The gains in power were unquestionably mostly central—that is, in the nerve centers—and not in the muscles. Yet there was also a strange but unquestionable gain in the size of the muscles at the same time.

We have arrived at the second step of the ladder, which is: The gain by practice which shows itself in cross-education consists in a development of higher nerve centers connected with the two sides

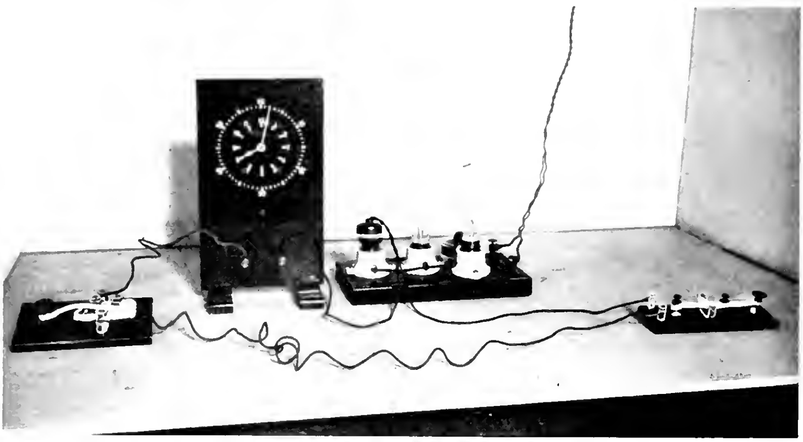


FIG. 1.

of the body. We must next ask: Is this effect of practice confined to the symmetrical organ, or does it extend to other organs? This question was answered by a peculiar experiment.

The experiment consisted in testing the effect of educating one of the feet to tap as rapidly as possible on a telegraph key. The apparatus is shown in Fig. 1. The clocklike instrument is really a piece of clockwork actuated by a magnet, so that it counts up one point every time the electric circuit is closed. The electric circuit is comprised of a battery and two keys. Any form of battery will do; the one in the figure is a "lamp battery"—that is, an arrangement of lamps in series and in shunt, such that the ordinary high-voltage city current is conveniently transformed into a low-voltage current. The key to the left is the experimenter's key, and that to the right the subject's key. When the subject is set to tapping on the latter key the counter will register whenever the experimenter keeps his key closed.

For the actual experiments by Professor Davis the subject's

key was removed to a distant room. Here there were three keys of this kind, any one of which would register. One key each was arranged for tapping with the big toes; the third key could be tapped by either right or left index finger.

On the first day all four digits—right and left index fingers and right and left large toes—were carefully tested in tapping as rapidly as possible. Thereafter the right large toe was practiced daily in tapping for several weeks, the other digits being left unpracticed. At the end all four digits were again tested. Four of the six persons experimented upon showed a gain for the right large toe—that is, for the digit practiced; the other two showed a slight loss, due unquestionably to "over-practice," or "over-training."

All of those who gained for the right large toe gained for the other digits also. Their average gains were: Right foot, thirty-three per cent; left foot, thirty-one per cent; right hand, twenty-one per cent; left hand, thirty-one per cent. Even both of the "over-trained" men gained for the left foot and one of them gained for the left hand. Thus we have reached the third step—the effects of practice are extended to various parts of the body.

Beyond the third step the experimental investigations have not yet advanced, but I believe that sooner or later we shall be able to establish the fact that development of those forms of the will involved in simple muscular activities does also develop the more complicated forms that express themselves in acts of a mental nature.

It has long been claimed that sports, games, and manual occupations are among the best developers of character. Football develops solidarity of feeling and action; running rapids or cross-country hunting develop coolness in danger and promptness and firmness of judgment; wood-turning requires boldness and foresight; forge work requires regulation and reserve of power, and so on. This is no place for an account of the psychology of sports and occupations, but if the reader has ever tried any of these things and failed he will easily recognize the lacking mental quality.

Yet there has never been but one attempt, as far as I can learn, to organize a system of manual occupations on the basis of this principle. The success of the attempt furnishes, I believe, the still-lacking laboratory proof of the principle itself. I refer to the remarkable experiment of Mr. Z. R. Brockway, Superintendent of the Elmira Reformatory.

Most of the young felons sent to the Elmira Reformatory are set to learning trades, by which they can support themselves on leaving. Those, however, who are too stupid to even learn the sim-

plest trade are put into a manual-training school, in the hope that their brains can be sufficiently developed to enable them to keep out of the prison or the asylum. Those who are so stupid that they have difficulty in learning the alphabet or in counting their fingers are put into a kindergarten, where they practice on letter blocks and sticks and straws.

Those who are too stupid to learn a trade are the ones of interest here. Three main lines of defect are recognized in Superintendent Brockway's classification of them. Those who are intellectually weak, but of fair power of self-control, are classed as Group I; those who are reasonably bright, but are unable to get along because they can not control their impulses, are classed as Group II; those who fail on both sides are classed as Group III.

Group II is composed of those who are for the most part devoid of moral sense—those who fight, swear, assault officers, are licentious, and generally unresponsive to the usual reformatory measures. To this class belong some of the most intellectual inmates of the reformatory, but this intellectuality runs riot on account of weakness of character. How are their characters to be built up? They are required to devote most of their waking hours to athletics and calisthenics, wood-turning, making wooden patterns for castings, mechanical drawing, sloyd, clay modeling, and chipping and filing metal. These exercises have been selected on account of their character-building qualities.

The work is a great success. Nearly all inmates subjected to this building-up process finally graduate with sufficient self-control from the manual-training department into the trades school. A concrete example will give an idea of the change produced in the pupil. The record of No. 6,361 is instructive. The account is taken from a report by the manual-training instructor, R. C. Bates:

"The pupil, previous to his assignment to manual training, had earned for himself the sobriquet of 'dangerous man' among the officers and inmates. His offenses have been mostly threatening language, lying, contraband articles, talking, fooling, assaulting officers, and institutional crimes of that nature.

"We begin his record in September, 1895, when he was reduced to the second grade for fighting. October and November he lost three marks each for lying and threatening language, and, by the influence of September markings, caused his reduction to the third grade, or incorrigibles, a closely defined group. He was in the third grade two months and three days, when he was placed in the foundry, where, amid blinding smoke, stifling air, and the task system, it was thought he would tone down, upon the theory that the muscular demands of such a place on a 124-pound body would vitiate

sufficiently to weaken the will and curb the disposition to riotous acts.

"From January 15th to February 15th he was on modified treatment. On February 18th he was unconditionally restored to the second grade. February and March he did fairly well, losing one mark each month, but in April his period of passably well-doing was checked by his committing an assault, along with assumption of authority, and on the 27th of April he was returned to the third grade for the second time, remaining in the same two months and three days, when he was again placed on modified treatment, and did well for three months, when he fell again, this time for fighting, losing six marks in October. In November he made a perfect month, securing promotion to second grade.

"On December 15, 1896, he was assigned to manual training, Group II; object, development of self-control, with subjects as follows: Athletics, drawing, sloyd, woodwork, chipping and filing, molding. Each subject one hour and a half per day, five days per week. The influence of the new environment sustained the effort made in November to improve, and, by securing a perfect month in December, all his past was blotted out and he was restored to the lower first grade again, through 'amnesty,' on December 25, 1896.

"Thus, on December 25, 1896, he was where he was institutionally classed at the time of his admittance two years and three months ago—viz., lower first grade, from which all who are committed begin the reformatory course of treatment, additionally thereto in the manual-training department. His development now begins. In January, 1897, he lost two marks as a result of school failures, but in February he secured a perfect demeanor record; in March he lost two marks; April and May were perfect months in all respects, and he was graduated from manual training in May, returned to institutional life, and assigned to the exercise squad in the morning and stone masonry in the afternoon. Later his daily assignment was changed, placing him in the molding class of the technological department to complete trade. His development was complete and permanent. He was returned to the manual training as *assistant instructor* in the molding class, and is now doing well in all departments, having been promoted to the upper first grade in August and ranking as sergeant in 'I' company."

This record is only one example of many.

When manual-training schools organize their courses on the principle of adapting the exercise to the ability to be developed, we shall have abundance of similar proof. When these facts have been incontestably established, there will be a means of satisfying the complaints of those who are constantly attacking our schools

because they develop intellect and ruin character. "What is the use," say they, "of teaching children to read and think if you do not make them honest and truthful? How is it better for the community to educate liars and thieves merely that they may lie and steal successfully in business and politics, where they can not be caught, rather than to leave them in the slums, where the police can get them?" The accusation is bitterly unjust in many ways, but its force can be met by introducing a system of character building based on a careful study of the means of developing truthfulness, honesty, carefulness, persistence, bravery, courage under defeat, and the other qualities that go to make up a true man. The foundation of this system is to be found, I believe, in the *principle of character-building by motor activity.*

The ladder of cross-education will be slowly climbed by psychological investigators; if they find at the top a principle of such value and wide application, surely the climb will have been worth the time and trouble.

THE MORBID "SENSE OF INJURY."

By W. F. BECKER, M. D.

As a fog about a ship removes it from exact relations to surroundings, so, from the standpoint of morbid psychology, we may fancy the mind peering through a more or less misty envelope to the true adjustment to things—the "glass" through which we see "darkly." Were all action and reaction of the mind to surroundings perfectly adapted, there could be such a thing as *absolute* sanity. So long, however, as evolution with continuous readaptation and the processes of dissolution with attempted adaptations continue, so long can there be but groping, imperfect relations to surroundings, so long must there be defective or morbid mental action, and sanity and insanity therefore but relative terms. Thus many symptoms of the insane appear to be but varying degrees of the morbid mental manifestations of health, and we may assume *a priori* that they have a common genesis and can be identified for study. If we take, for example, one of the commonest of these—viz., the idea of persecution among the insane—we may safely identify it with the "sense of injury" equally common among the sane.

By this "sense of injury" is meant that vague sense which afflicts many of us at times of being the object of hostile feelings on the part of others. No doubt we often *are*, for, in the stress of necessary rivalry and conflict upon which progress depends, we

give and take injuries. But there remains a large excess of this "injured" feeling which can not be so explained, or which is disproportionate to its cause or entirely gratuitous, and is thus shifted into the field of morbid psychology. This only is here treated—the *morbid* sense of injury.

It seems to find an easy entrance to the mind from a mere feeling of being ill used or stinted in sympathy to the entertainment of serious grievances or persecutory ideas. In certain temperaments it is marked. On so-called "blue" days we are constantly moved to a "sense of injury" from fancied aloofness of our friends. Madam Lofty slights us, and our jaundiced imagination has it that she has heard something detrimental and dislikes us. But lo! to-day, when the liver is released, madam smiles sweetly, and never heard a thing.

So in suspicious people. They entertain a chronic state of mind, by which the acts of others are given an invidious construction. They anticipate ill will, carrying the *chip* on the shoulder. Of two constructions of a given situation, they leap to the more offending. Some take on the vindictive attitude as a result, approaching that type of insanity known as *paranoia*, of which Guiteau and Prendergast were conspicuous examples; others are humiliated, as a consequence approaching the *melancholia* type of insanity, each illustrating again how the sane and insane states are paralleled. Many come to bear the outward marks—the stigmata of this mental attitude, approaching sometimes the "asylum" face, like that of the insanely suspicious Rousseau. We all know such faces, with their hard, set expressions, as if forever sealed against any tender of good will.

By a curious fact, those who invite ill will seem often to get it. Society, based on a reciprocity of faith, seems to have no smiles to bestow upon the misanthrope. It bids him, "Laugh, and the world laughs with you." It so comes to pass that many of them acquire some real ground for their "sense of injury," and in the long run that real quarrels are precipitated from this atmosphere of suspiciousness. Indeed, this is the psychology of most quarrels. The *effect* of imaginary grievances comes in turn to be the *cause* of real ones. Thus into an incident between two persons, one of them mistakenly reads an affront to himself. He retaliates, and the other person, unconscious of having done anything to evoke any hostility, finds *himself* affronted, and in *his* turn retaliates. By this time real grievances have come, and the quarrel is on. Balzac, that master analyst, in alluding to friendship, in one of his stories, says: "It died" (the friendship) "like other great passions—by a misunderstanding. Both sides imagine treachery,

pride prevents an understanding, and the rupture comes." Just as the malevolent feelings may arise *de novo*, so it is with the benevolent ones. Nordau shows how the nondescript state of being "in love" often arises. Some incident between John and Mary leads one of them—we will say John—to think mistakenly that Mary has been attracted to him. Pleased with the fact, he reciprocates. Mary, altogether unconscious of the reciprocal nature of John's attention, finds pleasure in it, and in *her* turn reciprocates. Mutual reciprocity then follows.

In irritable persons we find the morbid sense of injury coupled with resentment. Quickly interpreting anything disagreeable to them as an affront by another, their first impulse is to resent it, which they do more or less violently, according to circumstances, their second thought often recognizing the irrational nature of the outbreak. This suggests the feral instinct. Examples are common in the lower animals, while in pain attacking those about them as if they were the cause of it. No doubt this resentment is a survival from evolutionary ancestry. It has probably served a necessary purpose in the conservation of animal life by causing the animal to attack what may, in the jealousy of self-preservation and its feeble discrimination, even be suspected of being inimical to its welfare. Blind and unjust, perhaps, but Nature hesitates at no apparent injustice to accomplish this. When we go higher, to the tribal relation of man, we find the same blind resentment. The Australian aborigines have no conception of death, except as vaguely associated with homicidal causes, and when a member of a tribe dies a most natural death a member of a hostile tribe is killed to avenge the supposed murder. The Africans, too, read homicidal forces into natural deaths. In civilized social relations it appears again in the very popular and usually irrational demand for a scapegoat when matters go wrong. The idea of religious sacrifice, too, is a practice by which the anthropomorphic God is credited with being aggrieved by human conduct and of wishing to be appeased therefor. Though the exercise of this indiscriminate resentment was probably greater and more necessary in the pre-social stage of human evolution, there is still ground for its activity to-day in the struggle for existence which has but changed its arena. Under a veneer of amity, laudable enough, there are till the suspicion and resentment of the tribal relation, as we may often see unveiled in a posse of boys, and that this resentment is yet of the blind kind, we still have proof if we have seen an enlightened man deliberately kick a harmless chair because he stumbled on it in the dark.

Phylogenetically, then, we see this morbid "sense of injury"

to be reversional. This is in harmony with the atavic theory of insanity. In the individual it is a delusion, and, like other delusions, an attempt by the reason to explain a disordered feeling; in this case a *painful* feeling, having its origin broadly in some imperfect adaptation of the organism. This attempt to explain a feeling or sensation seems a human necessity. However wide of the truth such explanations usually are, we seem forced to attempt them. In the case of this *painful* feeling, with which we are here concerned, we are either unwilling or unable to explain it in its true way, and are prone to attribute it to malevolent agencies, often personal—perhaps the "bogy-man" remnant of the child and race. Such explanation is often an easy escape from truths unwelcome to our ego—truths which, if recognized, would wound pride or conscience beyond easy endurance. It requires a man of rare courage and mental clarity to recognize his particular pain from failure in adaptation as autogenetic, and to lay it to natural and unflattering causes. We prefer, of the two, to accuse the environment rather than the organism, especially when the organism happens to be our own. We take refuge in a grievance rather than impugn the supremacy of our ego. Indeed, it seems to be necessary for healthy subjective activity, so to speak, that a sort of *imperialism* of the ego, however circumscribed, be maintained. It is the condition *sine qua non* of the necessary measure of well-being of the individual. It is most reluctantly relinquished, and we constantly see the plainest truths immolated that it be retained. Only in the great self-effacement of melancholia and in those rare characters who recognize and bear complacently naked truths—the *Weltschmerz* of Goethe—is this well-being renounced. Even those who are willing to father their own wounded ego still seek the necessary approbation by reducing its future pretensions or claims so that they may not be again pained by their failure to achieve them. They *unhitch* their wagon from the star. Professor James has illustrated this by a fraction showing that our approbation is determined by our *success* divided by our *pretensions*. Thus, $\frac{\text{success}}{\text{pretensions}} = \text{approbation (self-esteem)}$. The quotient may be increased by diminishing the *pretensions* or by increasing the *success*. James's fraction is as applicable to the moral conduct as to the intellectual side.

When we look for the physical equivalent of the mental state which evokes the "sense of injury" we find it in dynamic and toxic states of the nervous system and their correlation. Certain conditions of the individual or environment bring these into special relief. Old age is one. The querulousness, the sense of abuse

or persecution which afflict the aged and often lead them to take refuge in the martyr-spirit, are sad examples. The state of fatigue or exhaustion is another, and "neurasthenic" insanity is only an expression in greater degree of the morbid mental action found in fatigue and exhausted states.

The primary and secondary effects of alcohol or other narcotic indulgence is another soil in which the "sense of injury" easily grows. The *habitué* is notoriously suspicious and irritable, and full of fictitious grievances and unwarranted persecutory ideas. His attitude toward them is that of the paranoiac, vindictive, rather than that of the melancholiac, humiliated. They swell the army of so-called "borderland" cases of insanity, fretting their friends and puzzling the doctor with conduct alternately interpreted as "cussed" or "crazy."

Where there is bodily disease, acute or chronic, the morbid "sense of injury" is much in play. An intelligent patient, on recovery from a stomach disorder, admitted that whenever her stomach had ached she was taken with a violent hatred of her companion with whom she was in affectionate relation. An ignorant Southern colored woman, who had rheumatism in her ankle, believed that she had been "hoodooed," and explained the pain in her ankle by the presence of a snake, which she believed had been put there by a "hoodoo." She was not insane, the idea being consistent with her degree of intelligence, training, and early environment. Another patient, a sensible, cultivated woman, while suffering from a non-nervous illness, in which she had received all the consideration that love and money could furnish, believed herself to have been constantly and deliberately abused. After her recovery, now some years, she still maintains the belief. Instances could be multiplied, for doctors continually meet this atmosphere in the sick-room, from ugly little grievances to delusions of persecution. They are not surprised when a patient tells them in mingled confidence and complaint that he is hungry and neglected, that "they" will give him nothing to eat, etc., to find that his wife has been most attentive, has been pressing him to eat, and has stocked the pantry in anticipation. Dr. Johnson had plenty of ground for saying that a sick man is a rascal, though the modern doctor has reversed the formula.

Persons who suffer from actual trouble or ill treatment easily develop a morbid sense of injury, just as under similar conditions they may become insane. Unable to estimate the precise amount of their real grievance, there is an easy mental overflow into the fictitious ones. It is for this reason that the narrative of a real trouble or quarrel is so fraught with calumnious arraignment of

others that it is unreliable until we have heard the "other side of the story," and that when disputants meet and explanations follow they often find that they have no *casus belli*. In the examination of the alleged insane for commitment we have constantly to separate the real from the imaginary troubles. Mr. F—— was the subject of such examination. He was suffering from heart disease, and thereby compelled to remain at home idle. His wife was supporting the family by keeping boarders, and he began to develop a morbid jealousy of her. He annoyed her by a constant surveillance and suspicion of her every act, which amounted at times to the delusion that she was unfaithful to him, and which culminated one night in an outbreak in which the police figured. It was difficult to separate his real from his imaginary grievances, for his wife had ceased to have any affection for him, though his delusion in regard to her unfaithfulness was unfounded and had been grafted upon his real trouble. Sent to a general hospital, he improved, and was reported "not insane." Circumstances requiring a hard struggle for existence, disappointment without apparent cause, coupled with a certain sentimental cast of mind, often prevent the correct estimation of the wrongs suffered and the proper relation of undoubted misfortunes.

In the insane the sense of injury or its analogue—delusions of persecution—appears in numerous shapes. Thus patients are defrauded, or conspired against, or acted upon by witchcraft, magnetism, electricity, or poisoned, or preached against, or subjected to disagreeable odors. Sometimes the delusions are but ill-defined and vague. Often it is possible to trace them to their underlying disordered sense impression or the particular environment or to vestiges of outgrown beliefs. They appear in depressed states of melancholia as well as in the exalted states of mania and paranoia. In melancholia they accompany a feeling of worthlessness which is the patient's explanation of his persecution—i. e., he is unworthy of better treatment. In paranoia the patient believes the persecution to be prompted by fear or envy of him, and there is consequently a feeling of self-importance—a morbid egotism which is in direct proportion to the magnitude or complexity of the ideas of persecution. Indeed, it is probable that these ideas of persecution, acting on a potentially melancholic or a potentially paranoiac mind, whatever these may be, determine the type that these mental diseases take.

The difference between the "injured" sense in the sane and insane states we must from our view point, without essaying to bridge all the *terra incognita* which lies between sanity and insanity, regard as largely but one of degree. And so with the underlying

mental and physical states. We find the morbid ideas more fixed in the sane than in the insane, frequent repetitions of the morbid impression tending to its final organization, so to speak. We also find that the morbid idea is usually more elaborated in the insane than in the sane state, although instances of the greatest elaboration are sometimes met with, especially where the element of some external foundation is large. It is probable, however, that the elements of fixity and elaboration of the persecutory idea are after all dependent upon and in proportion to the intensity of the underlying brain and mind states. In other words, that to increase a given intensity of these states is to increase the fixity and elaborateness of the "sense of injury," is to prevent the correction of the morbid idea, until finally exploited in conduct, which is the *début* of the insanity.

Thus the relativity of insanity which has all along been maintained is clear on the line here pursued. It would be equally so in following other lines of morbid psychology. It has, though, received but little general recognition, and writers still treat insanity as an entity apart from its bearings on the average mind and its evolutionary history. The word "insanity," or "lunatic," is no doubt largely responsible for this, suggesting popularly, as it does, a distinct class of persons—a type of being as unlike ourselves as a Martian might be fancied to be. Nature or science, however, has set no line between the morbid mental manifestations which constitute sanity and those which constitute insanity, that being an arbitrary, however practical, distinction which science has had rather to descend to meet. Nothing so stands in the way of the best welfare of the insane than this abysmal ignorance which still prevails in regard to them—an ignorance which still clings to the mediæval idea of insanity, the classical portraiture, as in the pictures of Hogarth, or on the stage, or in fiction; an ignorance which is ever hearkening for the maniac's shriek or the clanking of his fetters, which recognizes nothing short of "furious madness" as sufficient ground for committing a brain-sick man to the tender therapy of the hospital ward.

But those who know best tell us that the insane are very much like other people, that there is wonderfully little difference between them and ourselves; and sometimes but a slight circumstance, a mere accident of environment, determines which side of the hospital wall we shall be on.

EARLY EXPERIMENTS IN AIR FLIGHT.

By M. BANET RIVET.

MAN has sought in all times and at all places to find means of leaving the earth's surface, in imitation of the birds, and rising into the air. Ancient legendary lore furnishes many stories, like those of Dædalus and his son Icarus, of attempts of this sort. In the fourth century B. C., Archytas of Tarentum, a learned Pythagorean, who has been credited with the invention of the screw, the pulley, and the kite, according to Aulus Gellius, constructed a wooden dove which could rise and sustain itself in the air by some mechanism the arrangement of which is not known. Credible accounts exist of an English Benedictine monk, Oliver of Malmesbury, in the eleventh century, having tried to fly by precipitating himself from the height of a tower, with the assistance of wings attached to his arms and his feet. It is said that, after having gone along a little way, he fell and broke his legs. He attributed his accident to failure to provide his apparatus with a tail, which would have helped preserve his equilibrium and made the descent a gentler one.

In the sixteenth century, Leonardo da Vinci first demonstrated that a bird, which is heavier than the air, sustains itself, advances in the air, "by rendering the fluid denser where it passes than where it does not pass." In order to fly it has to fix its point of support on the air; its wing in the descending stroke exerts a pressure from above down, the reaction of which from below up forces the center of gravity of its body to ascend at each instant to the height at which the bird wishes to maintain it. Some sketches that have come down to us prove that Leonardo occupied himself, like Oliver of Malmesbury, with giving man power to fly by the aid of wings suitably fixed to his body. We owe to Leonardo also the invention of the parachute, which he described in the following terms: "If a man had a pavilion, each side of which was fifteen braces wide and twelve braces high, he might cast himself from any height whatever, without fear of danger." It may be said, too, of Leonardo da Vinci, that he was the first to suggest the idea of the screw propeller. "If," he said, "this instrument in the form of a screw is properly made—that is, made of linen cloth, the interstices of which have been filled with starch—and if we turn it rapidly, such a screw will make a bearing nut for itself through the air and rise. This can be proved by moving a broad, thin rule rapidly through the air, when it will be found that the arm is forced to follow in the direction of the edge

of the board. The frame for the cloth of which I have been speaking should be made of long, stout reeds. A model of it might be made in paper, with, for its axis, a thin strip of iron which we twist forcibly. When the strip is left free it will turn the screw."

In 1680 Borelli published some studies of a remarkably correct character on the flight of birds. According to his view, the wing acts upon the air in the phase of beating down, in the manner of an inclined plane, so as, by virtue of the resistance opposed by the air, to push the body of the animal upward at first and then onward. The action of the ascending wing was compared to that of a kite, and it would consequently continue to sustain the body of the bird while waiting the following stroke. But Borelli never thought of turning his observations to advantage, so as to supply man with the means of flying. Attention was much engaged in 1742 with the attempt of the Marquis de Bacqueville, substantially repeating that of Oliver of Malmesbury, which was terminated by a similar accident. Mention should also be made of Paucton, who in 1768 drafted a plan for a screw machine. In 1784 Launoy and Bienvenu exhibited and operated, before the Academy of Sciences in Paris, a screw which was moved by a strong spring. Before this, however, Joseph and Stephen Montgolfier had filled the world with the noise of their discovery of the air balloon, and the ingenious machine of these aëronauts failed to receive the attention it deserved.

It has been known since the days of Archimedes that every body partly or wholly submerged in a liquid in equilibrium suffers a vertical push upward from the fluid equal to the weight of liquid it displaces.

Let us consider the case of a body entirely plunged in a liquid—water, for example. If its weight exceeds the thrust it suffers it will fall to the bottom of the water under the action of a descensional force equal, at each instant, to the difference between the weight of the body, which is invariable, and the thrust, which is invariable also, and thus constant in direction and also in amount. If the weight of the body is less than the thrust, the latter overcomes it, and, contrary to the usual laws of weight, the body will rise under the action of an ascensional force, which will evidently be likewise constant in amount as well as in direction. A cork held down at the bottom of a vessel of water and then left to itself will supply an example of this ascensional movement.

A third case may be presented—that in which the weight of the body is equal to the thrust of the water. Weight and thrust are then in mutual equilibrium. No force invites the body either to descend or to rise, and it remains balanced in the midst of the

liquid, wherever it happens to have been placed. This state of indifferent equilibrium is, however, possible only if the weight of the body remains rigorously constant. The slightest augmentation of the weight immediately causes the body to descend, while the slightest diminution sends it up. From this source arise the difficulties that are met in the construction of submarine boats, when their ascent or descent is obtained by means of air chambers, which are filled with water or emptied of it according to the requirements. The equilibrium of these engines is always precarious, and this explains why none of them, from that of Van Drebbel in 1620 to the experiments of Goubet in 1895, have given really practical results in the matter of stability of immersion.

When Galileo, following Aristotle, had demonstrated the ponderability of the air, and Torricelli had proved that atmospheric pressure was a result of that property, it was immediately thought that the principle discovered by Archimedes might be extended to the air, and Otto von Guericke gave an experimental demonstration of it by the invention of the baroscope.

From this period it seems, then, that the discovery of aëronautics was possible. If the weight of the volume of air displaced is greater than that of the body, the latter should take an ascensional movement in the atmosphere, as a cork does when plunged into water; and it is evident that for a body to satisfy such conditions we have only to fill a very light envelope with a gas less dense than the ambient air. But the study of gases was still in its infancy in the seventeenth century, and it required the labors of Mortrel d'Élement and Hales, at the beginning of the following century, to teach physicists how to collect and retain them.

The history of the progress of the human mind shows, further, that the pure and simple acceptance of a scientific discovery is not enough to make it produce all the consequences we have a right to expect from it. It must, further, impregnating the mind with itself, pass, we might say, into the condition of an innate idea. Chemistry, in this very matter of the discovery of the weight of the air and of the gases, presents a striking example of the accuracy of our proposition. The ponderability of the air had been accepted by physicists for a long time, while chemists continued to take no account of it, although, as Mendeleef has remarked, no exact idea could be conceived, under such conditions, concerning most chemical phenomena. It is to the glory of Lavoisier that he first took account of this ponderability and of that of all the gases as well. When we reflect that it was not till about 1775, or a hundred and fifty years after Galileo, that this illustrious Frenchman began to set forth those ideas, it is not any wonder that the

discovery of aërostats was not made till toward the end of the eighteenth century. Lalande was therefore much in the wrong when he said "it was so simple! why was it not done before?"

It would not be just, however, to refer the discovery of aërostats solely to the efforts of the Montgolfiers. Like all inventors, like Lavoisier himself, these brothers, as Figuier has remarked, had the benefit of a long series of isolated labors, carried on often without special purpose, by which the elements of their invention had been gathered up.

Père Lana, of Brescia, conceived a plan in 1670 for constructing a ship which should sustain itself in the air and move by the aid of sails. Four copper globes, in which a vacuum had been produced in order to render them lighter than the volume of air displaced, were to support the ship while the sails propelled it. The scientific conception of the empty globes was correct, but Père Lana did not think of the enormous collapsing force which the atmospheric pressure would exercise upon them. The idea of a sail which would give his aërial boat a resemblance to a vessel driven by the winds was wholly erroneous.

Sixty-five years later, in 1735, Père Galien, of Avignon, gave a fairly clear expression to the theory of aërostats. Resting on the principle of Archimedes, he maintained that if he could fill a globe made of light cloth with a sufficiently rarefied air the globe would necessarily possess an ascensional force, which would permit it to lift itself up in the air with a ship and all its cargo. He proposed to draw this rarefied air from out of the upper regions of the atmosphere, down from the summits of high mountains, forgetting that the air, when brought down to the level of the ground, would contract in volume and assume the density of the ambient atmosphere.

In the condition of ignorance of the properties of gases that existed in that age, it did not occur, and could not have occurred, to Père Galien to use other gases than air; no more could he have thought of employing heat to rarefy the air, for the first not very precise notions on the decrease in densities of gases by heat only date from Priestley. But when Cavendish, in 1765, had fully studied hydrogen gas, and shown that as it was prepared then it was seven times lighter than air, Black was enabled to suggest that by filling a light bag with hydrogen the bag would be able to raise a certain weight in the air. The labors of Cavendish, Black, and the discoveries of oxygen, nitrogen, and other gases by Priestley, were described by Priestley a few years afterward in the celebrated book on The Different Kinds of Air—a book which Stephen and Joseph Montgolfier had in their possession.

The two brothers evidently found the germ of their invention in it.

It is fair to say that the Montgolfiers, who were already known in the learned world by their discoveries in the mechanical sciences, had thought, before they knew of Priestley's book, of a way of imitating Nature by inclosing vapor of water, a gas lighter than air, in a paper bag, which would be lifted up, the vapor contained in the bag being sustained in the air like a cloud. But the vapor condensed, and the weighted balloon shortly fell to the ground. The smoke produced by burning wood inclosed in a bag gave no better results. After seeing Priestley's book, they substituted hydrogen for vapor and for smoke, but the gas passed through the paper bag, and they gave up this attempt.

They then fancied that electricity was one of the causes of the rise of clouds, and sought for a gas that had electrical properties. They thought they could obtain it by burning wet straw and wool together. A box made of silk was filled with this gas, and they had the great satisfaction of seeing it rise to the ceiling of their room, and, in a second experiment, into the air. This was in November, 1782.

Five months previously, Tiberius Cavallo, in England, had repeated Black's experiment of filling a paper sack with hydrogen; but, as the Montgolfiers had found, the hydrogen leaked through the paper. Cavallo had better success with soap bubbles, which held the gas. His experiments stopped here, while the Montgolfiers carried theirs on to practical success.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF EDWARD ORTON,

LATE STATE GEOLOGIST OF OHIO; LATE PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ALL persons interested in American science were surprised and shocked at learning of the death, from heart trouble, on October 16, 1899, of Prof. Edward Orton, of the Ohio State University. The event occurred only little less than two months after Professor Orton had presided, with a simplicity of manner that did not hide but rather heightened the traits of vigor in his character, over the meeting of the American Association for the Advancement of Science at his home in Columbus, Ohio. The services he rendered to geology, his long and honorable career as an educator, and his continual and consistent insistence upon the faithful use of

the scientific method well entitle him to be remembered as one of the most meritorious of American scientific workers.

Edward Orton was born in Deposit, Delaware County, N. Y., March 9, 1829. He was descended from Thomas Orton, who, born in England in 1613, was one of the fifty-three original settlers and owners of Farmington, Conn., was of the stock from which most of the Ortons in the United States are derived, and represented his town in the General Court in 1784. Another ancestor, a grandson of Thomas Orton, was one of the original purchasers and settlers of Litchfield, Conn., where he owned a square mile of land known as Orton Hill, on the south side of Bantam Lake. Two of the maternal ancestors of the subject of this sketch fought in the colonial wars, and ten Ortons were soldiers in the Revolution.

Young Edward Orton was taught by his father, the Rev. Samuel G. Orton, D. D., and received further training preparatory for college in the academies of Westfield and Fredonia, N. Y. He entered Hamilton College, whence his father had been graduated in 1822, in 1845 as a sophomore, and was graduated in 1848 in a class among the other members of which were the Rev. Dr. Thomas S. Hastings, President of Union Theological Seminary, New York, and the Hon. F. J. Van Alstyne, afterward Mayor of Albany, N.Y., and member of Congress. After his graduation he taught for a number of years in academies at Erie, Pa., Franklin, N. Y., and Chester, N. Y., and became, in 1856, Professor of Natural Science in the State Normal School at Albany, N. Y. He pursued post-graduate studies in chemistry, botany, and other subjects at the Lawrence Scientific School, with Professors Horsford, Cooke, and Gray as his teachers, and studied theology for a time under Dr. Lyman Beecher, at Lane, and Dr. Edwards A. Park, at Andover Seminaries. While teaching at Chester, N. Y., he was called to Antioch College, Yellow Springs, Ohio, where he took charge of the preparatory department in 1865; was made Professor of Natural History shortly afterward, and was made president of the college in 1872, but retained the office for only one year, at the end of which he went to occupy a similar position in the State University at Columbus.

When the second Geological Survey of Ohio was undertaken in 1869 under the charge of Prof. J. S. Newberry, Professor Orton was appointed an assistant by Governor Rutherford B. Hayes, and was continued by reappointment by Governor E. F. Noyes. When Professor Newberry withdrew from the survey in 1881, Professor Orton was appointed State Geologist by Governor Charles Foster, and he was afterward reappointed to the position successively by Governors Hoadley, Foraker, Campbell, and Bushnell. He re-

tained the title of State Geologist till his death, although he had not been engaged in any active public work on the survey for a considerable time.

The Ohio State University having been established on the basis of the grants of land made to the States for colleges under the Morrill Land-Grant Act, Professor Orton was appointed its president and Professor of Geology. He discharged the duties of this office for eight years, or till 1881. But the executive work of the president's office was irksome to him, since it grew constantly heavier as the young college expanded, and therefore left him less and less time for teaching and research in geology. Being in a measure compelled to make a choice between the two fields of activity, he chose the less ambitious position, resigning the presidency, and assuming the position of Professor of Geology, which he retained for the remainder of his life. The geological building of the university is named after him—Orton Hall. Besides his work on the Geological Survey of Ohio and his participation in the composition of its reports, Professor Orton prepared, for the Eighth Annual Report of the United States Geological Survey, a paper on the New Oil and Gas Fields of Ohio and Indiana, and another, only recently published in the Nineteenth Annual Report of the United States Survey, on the Rock Waters of Ohio; a volume for the Geological Survey of Kentucky on the Petroliferous Production of the Western Part of the State, published in 1891; and a report on petroliferous productions which is in process of publication by the Geological Survey of New York.

In the paper on the Oil and Gas Fields of Ohio and Indiana the discovery of the supply of those materials, the great value of which was only realized in 1884 and afterward, is spoken of as being more surprising and anomalous than any similar discovery that had preceded it, and as a development which experts were hardly more prepared for than others. The oil and gas derived from the Trenton limestone in certain parts of these States were found to differ from the oil and gas in the Pennsylvania wells in chemical composition and physical properties, in the horizons from which they were obtained, in the structural features of the rocks associated with their production, and, most of all, in the kind of rock that produced them. "No facts more unexpected have ever been brought to light in connection with the geology of this country than those with which we are now becoming acquainted." Professor Orton's paper, which fills one hundred and eighty of the large pages of the report of the Geological Survey, includes a sketch of the history of the discovery to July, 1887, when it was prepared; a designation of what was known in regard to the geological scale and geological struc-

ture of the regions within which the new fields are embraced, and the tracing of the chief factors that influence or control the productiveness of the oil rock, with the description of the special features and boundaries of the several fields and the setting forth of the leading facts and present development of these lately found sources of power. Two principal conditions under which the new oil rock had proved petroliferous on a large scale were found to be porosity, connected with and apparently dependent on the chemical transformation of the upper portion of the limestone, for a number of feet in thickness, into a highly crystalline dolomite; and a relief resulting from slight warping of the strata, whereby the common contents of the porous portions of the Trenton limestone had been differentiated by gravity, the gas and oil seeking the highest levels, and the salt water maintaining a lower but definite elevation in every field. Professor Orton found nothing in the new experience to make it safe to count the Trenton limestone an oil rock or a gas rock in any locality, unless it could be shown to have undergone the dolomitic replacement by which its porosity was assured; and even in case it had suffered this transformation it would not be found a reservoir of gas or oil in an important sense unless some parts of it had acquired the relief essential to the due separation of its liquid and gaseous contents.

The report on the Rock Waters of Ohio concerns, first, those waters, chiefly in the northwestern and western part of the State, that are obtained from a considerable depth as compared with ordinary wells, the knowledge of which was almost wholly derived from wells drilled in the search for oil and gas, and was necessarily fragmentary and incomplete; because water was not included among the objects of search, but was considered a hindrance and obstruction to be got out of the way as well as possible; and, second, flowing wells, including only those having considerable head of pressure and those occurring in considerable areas, all of which belong entirely to the drift. Further, a brief review is given of some facts of unusual interest that were developed in the deep drillings concerning the preglacial drainage system of the part of the State in question. Indications of old river channels, one of which seems to have been extensive, were found at several points. Among the curious results of these studies was the conclusion, "seeming to be already established," "that the Ohio River, as we now know the stream, is of recent origin, and that the main volume of water gathered in it at the present time originally flowed across the State to the northward at least as far as Auglaize and Mercer Counties, where it turned to the westward toward the present lines of Wabash drainage in Indiana." Professor Orton seems to have

placed considerable emphasis on the value of a study of the rocky floor of the State, concerning which all we know at present is derived from the revelations of deep drillings at haphazard; and he thought it would be a good work for the State to make use of all accessible data of this kind at once in constructing a model of the rocky floor of the region under review. The care and fidelity with which he studied the underground geology are exemplified in a map attached to the paper on the oil and gas fields, in which the horizons of the Trenton limestone are indicated and approximately bounded as they occur by gradations ranging from fifty to two hundred and fifty feet, from elevations above the ocean level to one thousand and more feet below. Another contribution of Professor Orton's which may appropriately be given special notice is his part of the article on Ohio in the Encyclopædia Britannica, in which a succinct, clear, and comprehensive account of the geology of the whole State is given, with its salient features delineated so sharply that one may almost conceive from it a definite geological picture of the region.

Of all his scientific work, however, Professor Orton regarded the fixing of the order of the coal measures of Ohio as the most important; and he considered the determination of the order of the subcarboniferous strata, and particularly of the Berea Grit, as constituting a large permanent service to the study of the geology of the State.

At the recent meeting of the American Association for the Advancement of Science Professor Orton contributed a special paper on the local geology of Columbus, the place of the meeting, in which he dwelt largely on the origin of the drift that marks the superficial geology of the vicinity.

Of the work he has done for the increase and advancement of knowledge, the extent of a part of which we have only faintly indicated by the mention of a few particular researches, Professor Orton put the highest value on his labors as a teacher, a calling to which he was devoted for more than half a century. He found peculiar pleasure in instructing the children of the old pupils whom he had taught in his younger days. He was actively concerned in the promotion and extension of sanitary science, his addresses in that field having been one of the factors that led to the establishment of the Ohio State Board of Health. He was also greatly interested in the advancement of agriculture.

A theme on which Professor Orton was fond of dwelling in his public addresses was the amount and value of what has been accomplished within a comparatively short time in the world's history by the use of the methods of science. In an address delivered before

the alumni of Hamilton College in 1888 he maintained that we were living in a revolutionary period, which is marked by a great advance in knowledge and a vastly larger control of the forces of Nature; by a large increase in freedom of thought and action; by a sudden and remarkable addition to the mobility of man, accompanied by an unexampled growth of great cities; and by an incalculable addition to the wealth of the world. Accompanying these great changes in the material and intellectual world were certain moral transformations appearing to grow out of them. All these advances were ascribed to a movement—a new method of investigating Nature—that began, so far as its particular and continuous development is concerned, about three hundred years ago, but to which no date or founder's name could be attached. This new philosophy thoroughly respected Nature, was humble, patient in the accumulation of facts and the trial of its theories, comprehensive, progressive, and hopeful. It has given us the marvelous increase of knowledge which especially marks the nineteenth century; it has impressed its influence upon all branches of study, and has wrought great improvements in methods and results; and has rendered an immense and inestimable service to Christian theology, and done much to broaden and rationalize it and thus to perpetuate and strengthen its hold on the world. Finally, the method of science was pronounced "the best gift that God has given to the mind of man." A similar train of thought as to the material aspects is apparent, though in a somewhat different form, in an address on The Stored (or Fossil) Power of the World, delivered in 1894.

A considerable part of Professor Orton's presidential address at the last meeting of the American Association was devoted to a summary of the conclusions derived from Alfred Russell Wallace's book, The Wonderful Century, that the progress accomplished in the present century far outweighs the entire progress of the human race from the beginning up to 1800. In this address, also, the author felicitously spoke of the scope of the American Association as possibly including the whole continent, and its object as the advancement of science, the discovery of new truth. "It is possible that we could make ourselves more interesting to the general public if we occasionally forswore our loyalty to our name and spent a portion of our time in restating established truths." But the discoveries recorded, though often fragmentary and devoid of special interest to the outside world, all had a place in the great temple of knowledge; and the speaker hoped that although no great discoveries should be reported this time, the meeting might still be a memorable one through the inspiration it would give to the multitude of workers in the several fields of science.

Professor Orton was a member of several learned societies; was President of the Sanitary Association of Ohio in 1884 and 1885; received the degree of Ph. D. from Hamilton College in 1876, and that of LL. D. from the Ohio State University in 1881; was elected President of the Geological Society of America in 1896; and was designated at the Boston meeting of the American Association, 1898, as president for the Columbus meeting, 1899.

In addition to his interests in science and theology, Professor Orton was keenly alive to everything that bore on the history of man on this planet. He was long a member of the Ohio State Archæological and Historical Society, and had recently been made a member of its board of trustees. He was a prominent member of the Old Northwest Genealogical Society, and was the author of a volume, published in 1896, on the Genealogy of the Orton Family in America. The absolute freedom of his character from any desire for display or self-aggrandizement is well shown by the fact that in this volume, compiled, with enormous labor, in the spare minutes of a busy life, he cuts himself off with one paragraph of a hundred words, while devoting pages to contemporaneous members of the family of whom the world has never elsewhere heard.

He was stricken with hemiplegia in December, 1891, but was able to do a considerable amount of work in his profession afterward. A few days before his death he said, in a note, that he felt that he had lived out his allotted time, and that his work was done. He never met his classes again, though he continued able to be up and about his home till the hour of his death. He seemed to feel that the solemn event was drawing close, during the last two days of his life, and his mind was always busy with the great question, "If a man die, shall he live again?" He had formed an affirmative answer apparently, as he read Browning's Prospice repeatedly in his last hours, and seemed to find in it the greatest pleasure and solace. His death was a quiet and painless one—a fitting end to a beautiful life.

Statistics of cremation, presented by M. Bourneville at the recent annual meeting of the society in Paris, show that the number of incinerations at the Père Lachaise crematory has almost steadily increased since 1889, and that the whole number last year was 4,513, making 37,068 from the beginning. A fair proportion of the number were women. There are now in Europe and America seventy crematories, twenty-seven of which are in Italy and twenty in the United States. Cremation is making good progress in England, where four crematories are reported from, and two are in course of erection. Germany has six, where 423 incinerations took place in 1898; Switzerland and Sweden have two each, Denmark one, and one has been authorized in Norway.

Editor's Table.

A COMMISSION IN DIFFICULTIES.

THE synopsis which has been given to the press of the Thirteenth Annual Report of the Interstate Commerce Commission is not encouraging reading for those who like to believe in legislation as an infallible panacea for all public and social ills. The tone of the document indeed is very far from being one of triumph. The note struck in the very first paragraph is the need for more legislation to save the copious legislation already passed from proving ineffectual and abortive. Whether it is that Congress does not wish to make the work of the commission successful, or whether it has begun to have a wise distrust of its own powers, we can not say; but the commissioners complain bitterly of its inaction. We can not do better than quote their own words: "The reasons for the failure of the law to accomplish the purposes for which it was enacted have been so frequently and fully set forth that repetition can not add to their force or make them better understood. It is sufficient to say that the existing situation and the developments of the past year render more imperative than ever before the necessity for speedy and suitable legislation. We therefore renew the recommendations heretofore made, and earnestly urge their early consideration and adoption."

As the document proceeds, we see the good commissioners at war with the wicked railways, and it is impossible to resist the conclusion that, on the whole, the wicked railways have the best of it. The commissioners admit that certain cases which have come before the courts have been decided against them, and in favor of the railways; but they are far from disclosing the full extent of the discouragement, not to say mortification, they receive. The business of the commission is to interfere between the railways and their customers—the public—in the interest of the latter. The railways naturally consider this a rather one-sided function, and are not extremely zealous to aid in its performance. They have their own troubles with the public, and have no commission to come to their assistance. Everybody is after cheap railway rates, just as everybody is after cheap goods; and the means sometimes resorted to to get reductions would at least hold their own for astuteness with any that could be concocted in a traffic office for the raising of rates. We give the commissioners full credit for doing their best to protect the interests of the public, but we can not help doubting whether, on the whole, the public has derived much benefit from their efforts. In fact, we are strongly inclined to the opinion that the whole idea of the commission is simply a legislative blunder.

The railways undoubtedly possess great powers which theoretically there is nothing to prevent their abusing to almost any extent. But what is theoretically possible is not always practically possible. The President of the United States possesses great powers, which theoretically he might abuse to any extent; so does the Queen of England; so do many other potentates. But of all the evil that is theoretically possible, how much is carried out in practice? All kinds of things *might* happen if people were fools enough to do all the harm that it is in their power to do. The great saving fact is that it is not possible to go very

far in doing harm to others without doing it to yourself. It is this fact which the insatiable legislation-monger ignores. He has an infinite faith in the mischief that will happen if things are left alone. He can not bear to think that somebody is not looking after everybody. He has no faith whatever in natural law or natural actions and reactions, and would hoot the idea of what the poet Wordsworth calls a "wise passiveness." Such people have little conception of the mischief they do, and of the good that fails of realization through their pestilent activity. The readers of Dickens will perhaps remember Mrs. Pardiggle and the admirable system of education she applied to her numerous family of children. The unhappy youngsters were under orders every hour of the day; they were marched round the country with their mother when she went on visits of charity, and compelled to contribute out of their own (nominal) pocket money to all kinds of religious and benevolent schemes. How they kicked and rebelled, and what distressing passions were roused in their youthful breasts, the great novelist has told us; and we think we may take his word for it. The fussy legislator is a Pardiggle. If he would leave things alone, opposing interests would find a *modus vivendi*, and practical justice would more and more assert itself. The more interference there is between parties who in the last resort are dependent on one another's good will, the less likely they are to recognize their substantial identity of interest. If the interference is wholly in the interest of one of the parties, the other is sure to be forced into an undesirable attitude; while the one whose protection is the object in view will not unnaturally take all the protection he can get, and look for something more.

What is wanted to put the relations between the railways and the public upon the most satisfactory footing possible is, in the first place, less legislative interference; and, in the second, a higher tone of business morality throughout the community. We place this second not as underrating its importance, but because we believe it would to some extent flow from the first. It is when the public transfers its right of eminent domain to a railway corporation that it should take adequate measures to protect its own interests; but how can this be done when legislation is sold—when charters are given or withheld, according to the amount of money available for purposes of persuasion? With honest legislators and honest courts there would be very little trouble between the railways and the public, and such as arose could be easily remedied. Commerce commissions are a testimony to the existence of low standards of business morality; and, unfortunately, they tend to keep them low, if not to make them lower.

The sooner we make up our minds to trust more to moral influences freely acting in the intercourse of man with man and of interest with interest, and less to legal compulsion, the better it will be for us in every department of our national life. The Thirteenth Annual Report of the Interstate Commerce Commission is a virtual confession of the failure of legislation to accomplish a purpose which was supposed to be easily within its field of action. The confession is coupled with a demand for more legislation, but, were the demand conceded, who can guarantee that more still would not be wanted? The railways are not at the end of their resources, and new laws would, we fear, be only too likely to suggest new means of evasion. No: the remedy lies elsewhere, and if Congress is wise it will give that remedy a trial by

allowing the railways and the public a chance to arrange terms between them, with public opinion as the principal court of appeal.

THE FUNCTION OF THE PUBLIC LIBRARY.

A paper that was read by Mr. Lindsay Swift, of the Boston Public Library, at a meeting of the Massachusetts Library Club, on the subject of Paternalism in Public Libraries, and which we find in the Library Journal for November last, is one which, in our opinion, deserves to be separately printed and widely circulated. It abounds in good sense, and preaches a doctrine of self-help and self-reliance which is much needed in these days.

A question which the author of the paper does not discuss, but which, it seems to us, lies at the threshold of the whole subject, is whether the very existence of a public library—if we understand by the term a library supported by public taxes—is not in itself an exemplification of paternalism. Mr. Swift strikes us as a benevolent bureaucrat who wants to give the people at large a wider liberty in the matter of reading than the ruling influences of time and place are disposed to allow. He sees that liberty is good, that leading strings belong to infancy, and he raises his protest against a paternalism in the management of public libraries which, under the plea of providing only the most approved reading for all classes, would tend to the repression of individuality in the reader and the establishment of the supremacy of commonplace. But what if commonplace insists on being supreme and shutting out whatever is not of one complexion with itself? How are we to resist its demand in the administration of a State-supported, and therefore majority-ruled, institution? "You offer us," say its representatives, "a liberty we do not want for ourselves, and are not prepared to concede to others, as we are sure it can not be for their good. We are not going to consult the tastes of cranks, criminals, intellectual aristocrats, or social mugwumps of any kind. For all practical purposes we are the public, and we mean to run this public library." To the objection that a portion, at least, of the taxes is paid by those whose views and tastes are not going to be consulted, the answer would be ready: "It is for the majority to say how taxes shall be applied." We recognize the excellence of Mr. Swift's intentions and sympathize with his way of looking at things, but we feel that his objections to "paternalism" in connection with public libraries are delivered from a somewhat shaky platform. We observe that a periodical quoted in the Library Journal—the Overland Monthly—makes the remark that "there is nothing to be said for free books that could not be urged in favor of free beefsteaks and free overcoats."

Some of the points, however, that are made by Mr. Swift are deserving of attention. The several professions—law, medicine, theology, etc.—would more or less like to have only such books placed upon the shelves of a public library as represent what may be called their respective orthodoxies. But, as Mr. Swift observes, "libraries are as much the depositories of the folly as of the wisdom of the ages." A library, therefore, should tell us what men have thought and attempted in the past, and what they are thinking and attempting now. It is for schools and colleges, for newspapers and reviews, to afford guidance in the wilderness of opinions, not for the library to make a point of putting out of people's reach everything that is not in line with the scientific, literary, or other orthodoxy of the hour.

"A subtle form of paternalism is the deliberate inculcation of the patriotic spirit, especially in children." Mr. Swift is a brave man to attempt to stem this particular torrent. He thinks there are times when one who loves his country would feel shame for it rather than pride, and that the motto "My country right or wrong" is not the most wholesome sentiment that can be impressed on the mind of youth. "To fill a child with the consummate virtues of Washington, Jefferson, and other of our immortals. and to leave him ignorant of the greatness of Cromwell and of William the Silent, is a serious injustice to the child and to the cause of education." Not only is this done, but, in the domain of literature as well, it seems as if the only names with which public-school pupils obtain any acquaintance are those of national authors. So far as poetry is concerned, Mr. Swift says that almost the only name he hears from the lips of children frequenting the Public Library is "Longfellow." He can not remember ever having had a call from a child for Tennyson, while Wordsworth in the school region is equally unknown.

Apart from the studied inculcation of a narrow patriotism, the author of the paper we are considering thinks that there is altogether too much paternalism shown in the choice of children's reading. He has only a limited and feeble faith in "children's rooms" in public libraries. They are very much, he thinks, like Sunday schools—convenient places for parents to unload their offspring. The aim of the censorship is to eliminate everything that is not in accord with the most approved canons of juvenile life and thought, leaving only what is ready for immediate acceptance and assimilation. Such a policy, Mr. Swift holds, is not favorable either to individuality or to intellectual growth. "We must," he says, "take books, like life, as we find them, and learn to distinguish good and bad; learn, as we ought, that the good is not so good as we have been told it is, and that the bad contains a strong infusion of good. No wrecks are so fearful as those which come to the young who have up to a point led 'sheltered lives.'"

It is not, however, children only who get the benefit of a benevolent protective policy. Selecting committees are quite prepared to look after grown-up people as well, and keep out of their way books which might prove too exciting, which might reveal depths of passion such as persons leading decorous lives are not supposed to know anything about, or otherwise agitate the tranquil mill pond of their existence. It does not occur to them that thus the salt and savor of human life are expelled, and that, instead of the free play of vital forces, there supervenes a dreary mechanic round of semi-automatic activities unvisited by enthusiasm, untouched by strong desire, without dream or vision or any quickening of the heart or the imagination. Some good people are excessively particular not only as to what may threaten moral disturbance, but as to anything that may encourage departures from conventional modes of speech and deportment. They do not like to admit books that they regard as vulgar, and a great mark of vulgarity in their opinion is the use of slang. Yet so accomplished a *littérateur* as Mr. William Archer told us lately that he pleads guilty to "an unholy relish" for the talk of "Chimmie Fadden" and his Chicago contemporary "Artie." To him, as to Mr. Swift, the books in which these worthies disport themselves *mean something*, and something deserving of attention. That being the case, the vulgarity, which is part of

the picture, becomes in proportion to its truth an element of value. Mr. Swift, very bold and like the ancient prophet, says plainly: "Harmless books in general are mediocre books; if a new note in morals or society is struck, the suggestion of a possible injuriousness at once arises."

Taken as a whole, Mr. Swift's paper is a strong plea for individualism and liberty. As such we have felt it a duty to call attention to it, and we trust that it will in some way obtain a more general circulation than can be afforded by the useful, but somewhat technical, columns of the Library Journal.

Fragments of Science.

Longevity of Whales.—Some light was thrown, a few years ago, upon the subject of the vitality of whales by finding one of these animals in Bering Sea, in 1890, with a "toggle" harpoon head in its body bearing the mark of the American whaler Montezuma. That vessel was engaged in whaling in Bering Sea about ten years, but not later than 1854. She was afterward sold to the Government, and was sunk in Charleston Harbor during the civil war to serve as an obstruction. Hence, it is estimated, the whale must have carried the harpoon not less than thirty-six years. In connection with this fact, Mr. William H. Dall gives an account, in the National Geographic Magazine, of a discussion with Captain E. P. Herendeen, of the United States National Museum, of cases of whales that have been supposed to have made their way from Greenland waters to Bering Strait, and to have been identified by the harpoons they carried. While it is very likely that the whale really makes the passage, an uncertainty must always be allowed, for ships were often changing ownership and their tools were sold and put on board of other vessels, and harpoon irons were sometimes given or traded to Eskimos. It therefore becomes possible that the animal was struck with a second-hand iron.

Solidification of Hydrogen.—As soon as he was able to obtain liquid hydrogen in manageable quantities, in the fall of 1898, Mr. James Dewar began experiments for its solidification. The apparatus he used was like that employed in other solidification experiments, consisting of a small vacuum test-tube, containing the hydrogen, placed in a larger vessel of the same kind, with excess of the hydrogen partly filling the circular space between the two tubes. No solidification was produced, and the effort was suspended for a time, while the author attacked other problems. The experiments were renewed in 1899, with the advantage of more knowledge concerning reductions of temperature brought about by reduction of pressure. A slight leak of air in the apparatus was observed, which was frozen into an air snow when it met the cold vapor of hydrogen coming off, and this leak at a particular point of pressure caused a sudden solidification of the liquid hydrogen into a mass like frozen foam. An apparatus was then arranged that could be overturned, so that if any of the hydrogen was still liquid it would run out. None ran out, but by the aid of a strong light on the side of the apparatus opposite the eye the hydrogen was seen as a solid ice in the lower part, while the surface looked frothy. The melting point of hydrogen ice was determined at about 16° or 17° absolute (−257° or −256° C.). The solid seemed to possess the properties of the non-metallic elements rather than of the metals, among which it has been usual to class hydrogen.

The Gegenschein.—Much interest prevails among astronomers at present concerning the question of the nature of the *Gegenschein*. This German word, which means "opposite shine," is applied to designate a small, somewhat oblong, bright spot which is sometimes

seen in the sky at night, nearly opposite the point which is at the time occupied by the sun on the opposite side of the globe. It is near the ecliptic, but appears two or three degrees away from exact opposition to the sun. It seems agreed that the *Gegenschein* is not atmospheric, but rather meteoric, being a reflection from some collection of meteors. The problem set before astronomers is to identify the meteors. A theory that they are connected with the asteroidal zone, or mass of meteors of which the known and numbered asteroids are conspicuous examples, has, according to Professor Barnard, "much in its favor, but there are objections to the theory which can not easily be reconciled with the observed facts." Mr. J. Evershed, of Kenley, England, assumes the *Gegenschein* to be a tail to the earth, produced by the escape of molecules of hydrogen and helium away from the globe in a direction opposite to the sun—much as a comet's tail is formed. Other observers suppose it to be connected with the zodiacal light or band, which is regarded as a body of meteors connected with the earth and accompanying it, and is plainly visible in the western sky after sunset in the spring, rising from the place of the sun toward the zenith; and Mr. William Anderson, of Madeira, publishes a figure with a demonstration, in The Observatory, to show how its place and appearance may be accounted for on this supposition. The *Gegenschein* has been compared in a homely way to the radiance which may be seen around the shadows of our heads cast by the sun upon the dewy grass early on a bright summer morning.

Literature for Children.—Mr. Richard le Gallienne, in an article published in the Boston Transcript, laments the flood of rubbish that is poured out under the guise of children's books. The subject of literature for children is discussed in the Studies of the Colorado Scientific Society by Prof. E. S. Parsons, who remarks that three of the greatest classics of childhood were not written for children at all. "Pilgrim's Progress was a new type of sermon written by the tinker preacher in his prison cell at Bedford; Robinson Crusoe was a pseudo-history from the pen of one of the first great English realists; Gulliver's Travels was a political satire by the greatest of English satirists. The same thing is true of the stories of the Bible, of the Arabian Nights, of the folklore which strikes a sympathetic chord at once in the child's nature. . . . Child study, then, reveals the fact that the child nature is the counterpart of what is best in books—that children can appreciate literature." A friend of Professor Parsons wrote him of her daughter, nine years old, being very fond of her father's library, and "simply devoted" to the Bible and the plays of Shakespeare. Harriet Martineau, when a child, "devoured all of Shakespeare," sitting on a footstool and reading by firelight, and making shirts, with Goldsmith or Thomson or Milton where she could glance at them occasionally. Another of Professor Parsons's friends read "all of Goethe's Faust with his little thirteen-year-old girl, to her great enjoyment," and the little girl afterward read alone all of Chaucer's Canterbury Tales. "Many teachers have found young children delighted with Dante." These incidents and others point to the inference that it is not necessary to go outside of the world's great literature for fit material for a child's imaginative and emotional nature. One of Mr. Le Gallienne's main conclusions is that it is very hard to guess beforehand what the child will like.

Geography and Exploration in 1899.—No great geographical discoveries were recorded during 1899, but much good work was done in exploration. Considerable interest has been taken in preparing expeditions of antarctic research, of which a Belgian expedition has returned with some important results, and Mr. Borchgrevink has begun work at Cape Adar, on the antarctic mainland. The search for Andrée has helped increase our knowledge of parts of the arctic coast. In Asia, Captain Deasy has laid down the whole of the before unknown course of the Yarkand River, and has furnished other information concerning little-known regions; and other surveys and explorations have been diligently prosecuted. About as much may be said of Africa, where "the want of adequate exploration of the mountainous regions on the borders of

Cape Colony and Natal has been only too forcibly brought home" to the English. Expeditions sent out by Canadian surveys are constantly opening up new countries and producing maps of great geographical and industrial value. Mr. A. P. Low finds Labrador not quite so bleak and hopeless a country as had been generally believed. Sir Martin Conway has done some very creditable exploration in the Andes and in Tierra del Fuego, the scientific results of which are of considerable value. In Chile, Dr. Staffer and his colleagues have been exploring the wonderful fiords of the coast and the rivers that come down to them from the Andean range. Dr. Moreno has described the results of twenty-five years' exploration of the great Patagonian plains, and of the lakes and glaciers and mountains on the eastern face of the Andes. One of the most important scientific enterprises during the year, the London Times says, was the German oceanographical expedition in the Valdivia, under Professor Chum, which went south through the Atlantic to the edge of the antarctic ice, and north through the Indian Ocean to Sumatra, and home through the Red Sea.

Royal Society Medalists. — The Copley medal was conferred, at the recent anniversary meeting of the Royal Society, upon Lord Rayleigh for his splendid service to physics, his investigations, the president said in presenting the award, having increased our knowledge in almost every department of physical science, covering the experimental as well as the mathematical parts of the subject. "His researches, from the range of subjects they cover, their abundance, and their importance, have rarely been paralleled in the history of physical science." A summary account of the principal ones was given in the sketch of him published in the twenty-fifth volume of the Popular Science Monthly (October, 1884). At the same meeting of the Royal Society the Royal medals were conferred upon Prof. G. F. Fitzgerald, for his brilliant contributions to physics, and Prof. William C. McIntosh, for his very important labors as a zoölogist. Professor Fitzgerald's investigations have been in the field of radiation and electrical theory, and in a manner complementary to those of J. Clerke Maxwell. Among his works is a memoir presenting a dynamic formulation of the electric theory of light on the basis of the principle of least action, which concludes with a remark upon the advantage of "emancipating our minds from the thraldom of a material ether." Professor McIntosh was spoken of as "one of a distinguished succession of monographers of the British fauna, who, beginning with Edward Forbes, have, during the last fifty years, done work highly creditable to British zoölogy." He is author of a great monograph of the British Annelids, which is still in progress of publication by the Royal Society, and of an important contribution to the Challenger reports, and was the founder of the first marine biological station in Great Britain—the Gatty Marine Laboratory at St. Andrews. The Davy medal was bestowed upon Edward Schunck for researches of very high importance in organic chemistry. These works include a remarkable series of contributions to the chemistry of the organic coloring matters, particularly those relating to the indigo plant and to the madder plant. Of late years he has studied, with distinguished success, the chemistry of chlorophyll.

Anglo-Saxon Superiority. — The question of the superiority of the Anglo-Saxon race is at present interesting economists of other stocks, especially of the supposed Latin races. The fact of superiority seems to be conceded. The problem is to account for it. A French writer, M. Dumoulins, attributes it to the superiority of Anglo-Saxon educational institutions. Signor G. Sergi, the distinguished Italian anthropologist, thinks it is a result of the mixture of ethnic elements of which the English people are made up, and he goes over the history of the colonizations which have overtaken Britain, to show how upon the first neolithic settlers of the Mediterranean stocks came a small emigration of the Asiatic Aryan or Indo-European peoples. Cæsar's conquest brought in a Roman infusion with some African elements, which did not last long, but left their mark. Next the Anglo-Saxon tribes of northern Germany made the principal contribution to the formation of the English people. A portion of Scandinavian blood was added to

the composition, and on top of all came the Normans. These elements, none of which were extremely discordant with the others, became thoroughly mixed in the course of time, and matured into the English people as it is. The English resemble the Romans in their methods of colonization, political tact, practical sense, persistence, religious tolerance, the magnitude of their works and the boldness of their undertakings, and in their egotism working together with the principle of social solidarity. Both readily established themselves in new colonies, carrying there the civilization of the mother country and their systems of administration. The great roads and wonderful bridges constructed by the Romans are paralleled by the great Anglo-Saxon railway systems. As the Latin language became almost universal, so the English language is diffusing itself everywhere. But Signor Sergi fails to show why, if the English have taken so much from the Romans, the Italians, their direct descendants, have lost so much of what they once had. He reserves that question, after raising it, for future consideration.

Carbonic Acid and Climate.—The great importance of the carbonic acid in the atmosphere as a factor in determining the climate of the earth has been confirmed by the researches of a considerable number of investigators. Its work appears to be that of an absorbent of the sun's radiant heat, retaining it and preventing its passing by us and leaving us in the cold temperature of space. Tyndall computes that it has in this capacity a power eighty times that of oxygen or nitrogen, while it is excelled by water vapor with ninety-two times that of those gases. Lecher and Pretner, on the other hand, believe that carbonic acid is the only agent concerned in the service. Mr. Cyrus F. Talman, Jr., in view of the fact that carbonic acid is an important factor among geological agencies, has published, in the Journal of Geology, a study of the conditions of the content of that gas in the ocean, a study that leads to the consideration of the chemistry of the ocean. It seems to be clear that with falling temperature the ocean will dissolve carbonic acid from the air. Dr. T. C. Chamberlin has shown that the amount of carbonic acid in the atmosphere at any one time, and therefore the climate of the earth at that time, depends upon the value of the ratio of the supply of the gas to its depletion. Besides the continuous supply that the atmosphere receives from the interior of the earth and from planetary space and the continuous depletion due to the formation of carbonates in place of the igneous alkali earth silicates, there are variations in the ratio of supply to depletion dependent upon the attitude of the land and the water. A large exposure of land surface is correlated with a rapid solution of calcium and magnesium carbonates, which, becoming bicarbonates, represent a loss of carbonic acid to the atmosphere. On the other hand, the formation of the normal carbonate by lime-secreting animals causes a direct liberation of the second equivalent of the bicarbonate. Therefore extensive oceans and abundant marine life are correlated with warm climate. After a somewhat more minute discussion of the action, Mr. Talman concludes that the ocean very greatly intensifies the secular variation of the earth's temperature, although acting as a moderating agent in the minor cycles.

Pearl Mussels.—In his report to the United States Fish Commission on the Pearly Fresh-Water Mussels of the United States, Mr. Charles T. Simpson speaks of the great variety of conditions under which they live. They show great capacity for adaptation. Most of them are found in shallow water, but certain forms live at considerable depths. Some bury themselves among the fibrous roots of trees, some in the muddy, sandy banks just below the surface of the water, and some, as in Lake Tiberias (Palestine) and Lake Tanganyika (Africa), under six hundred or more feet of water. Ordinarily they die in a very short time if taken out of the water—in from twenty-four to forty-eight hours, as a rule—and they generally die in a few hours when exposed to the sun. But many species, thus tender in the open air, will lie buried in dried mud for a long time. In June, 1850, a living pond mussel was sent to London, from Australia, which had been out of water for more than a year. Along a small stream near Braidentown,

Fla., which runs only during about three months in summer and is dry the rest of the year, thousands of a large colony of *Unio obesus* may be found just buried in the sandy banks or among the flags and rushes of the bottom, where there is very little moisture, all in healthy condition. Mr. Simpson has laid these mussels in the sun for months without killing them. The specimens which live in perennial water seem to die soon if removed from it, while those which inhabit streams or ponds that often dry up will live a long time out of water. Some species in rocky streams live in the crevices of the rocks. In the Big Vermilion River, in La Salle County, Illinois, a swift, rocky stream, the author has found living mussels that had been so washed about that nearly all the epidermis was destroyed. The shells in such streams are usually heavier than those in more quiet water.

MINOR PARAGRAPHS.

Prof. Frederick Starr, of the University of Chicago, has made two excursions to Mexico for the purpose of establishing the physical types of the aborigines by means of measurements, photographs, and casts. He studied twelve tribes, half of which were almost unknown to science, and made measurements of more than eleven hundred and fifty men and three hundred women. On his last trip he rode one thousand miles among the mountains on horseback. In a recent paper in the Open Court he takes notice of frequent and curious survivals of pagan belief to be remarked among these peoples, although they are all supposed to be devout Christians. In one instance, which is specially described, an idol bearing some resemblance to those found among the ruins of the ancient cities occupied a station in the church by the side of the crucifix, sharing the honors with the statue of the Virgin on the other side. Grief and consternation prevailed among the Indians when the idol was taken away by the ecclesiastical authorities.

The question of the increase of insanity in England during the last few years is regarded as assuming a serious aspect, and the report of the Commissioners of Lunacy for 1898, showing the largest annual increase yet recorded, the Lancet says, reveals the gravity of the situation. Other collateral facts given in the report "add to the seriousness of the outlook." The increase in the number of inmates in institutions for lunatics is attended with a falling off in the recovery rate, which is lower for 1898 than that of the previous year, and even than the average of the last ten years. A steady diminution in the recovery rate has appeared also during each period of five years since 1873. The attempt to account for the increase of lunatics in public and private asylums by supposing that it is made up by removals thither from workhouses or from the care of relatives fails, for it is shown that this class of insane is increasing too, though slowly. The subject is regarded as of so much importance that it was considered and discussed in the Psychological Section of the British Association at its Bristol meeting in 1899.

A process by which calcium carbide can be continuously produced more cheaply than by the process at present in use is reported, in Industries and Iron, to have been discovered by Professor Freeman, of Chicago. In the new process a huge arc lamp inclosed in brickwork in the interior of a furnace is employed. The upper electrode of the lamp is hollow, and through it is fed a powder composed of common lime and coke. This powder, being carried through the upper carbon directly into the electric flame, is melted by the intense heat, and molten calcium carbide runs away from the furnace. It is estimated that the carbide is produced at a cost of half a cent per pound.

NOTES.

A new method of securing more perfect combustion, described by Mr. Paul J. Schlicht before the Franklin Institute, is based on the fact, described by the inventor, that if a current of air is properly introduced into a chimney flue through which hot products of combustion are escaping, it will flow in a direction contrary to theirs, and, becoming heated in contact with them, will reach

the center of the fire in a condition highly favorable to the most complete union of oxygen with the combustible elements of the fuel. Suggestions are made in Mr. Schlicht's paper for the construction and regulation of furnaces, so as to secure the condition described.

Mr. Edward Orton, Jr., has been appointed State Geologist of Ohio, to succeed his father, the late Dr. Edward Orton. He has been connected, as an assistant, with the survey, in which he studied the distribution of the coal measures, and has also prepared reports on the clay and clay industries of the State.

"From a moral if not from a scientific and industrial point of view, incontestably superior to that of the European peoples," is the characterization a book reviewer in the *Revue Scientifique* gives to Chinese civilization.

Sir William Turner is the president-elect for the Bradford meeting of the British Association, 1900. He is head of the great medical school at Edinburgh, and President of the General Medical Council, and was pronounced by Lord Lister, in nominating him, the foremost human anatomist in the British Islands, and also a great anthropologist.

A gold medal is offered by the Society of Agricultural Industry and Commerce of Milan to the inventor of the best apparatus or the person who will make known the best method for protecting working electricians against the accidents of their profession. The competition is open to all nations.

The statue of Lavoisier, called by the French "the founder of chemistry," is to be erected, during the Universal Exposition in Paris, on the square of the Madeleine, at the intersection of the Rue Tronchet. The work is in charge of the sculptor Barrias. The sum of ninety-eight thousand francs, or nineteen thousand six hundred dollars, has been subscribed to pay for it.

The death list of the last few weeks of men known in science includes a considerable proportion of important names. Among the number are John B. Stallo, formerly of Cincinnati, author of General Principles of the Philosophy of Nature, The Concepts and Theories of Modern Science, and numerous contributions to scientific publications, recently United States minister to Italy, in Florence, December 30th, in his seventy-fifth year; Sir James Paget, for many years the leading surgeon in England, and author of books relating to surgery, in London, December 30th, in his eighty-sixth year; Dr. Thomas C. Egleston, Emeritus Professor of Mineralogy and Metallurgy in Columbia University, in New York, January 15th; Prof. Henry Allen Hazen, one of the chief forecasters of the United States Weather Bureau, and author of improvements in the methods employed there, in Washington, from the results of a bicycle collision, January 22d, in his fifty-first year; Dr. Wilhelm Zenker, a distinguished physicist, at Berlin, October 21st, aged seventy years; Augustus Doerflinger, an engineer who was engaged in the work of the removal of Hell Gate in New York Harbor, at Brooklyn, November 24th, in his fifty-eighth year; Johann Carl Wilhelm Ferdinand Tiemann, Professor of Chemistry in the University of Berlin and late editor of the Reports of the German Chemical Society, at Meran, Tyrol, November 17th, in his fifty-second year; he was distinguished for his researches upon the constitution of odoriferous principles, including works on vanillin, the aroma of the violet, terpenes, and camphor, and the synthesis of amido-acids; Dr. Birch-Hirschfeld, Professor of Pathology in the University of Berlin, aged fifty-seven years; Sir Richard Thorne Thorne, principal medical officer to the Local Government Board, in London, December 18th, aged fifty-eight years; author of many official reports relating to the public health, of works on the progress of preventive medicine during the Victorian era, and of lectures on diphtheria and the administrative control of tuberculosis; Dr. John Frederick Hodges, Professor of Agriculture and lecturer on medical jurisprudence in Queen's College, Belfast, Ireland, and author of two elementary books on chemistry, The Structure and Physiology of the Animals of the Farm, and of several papers published in the Proceedings of Scientific Societies; E. C. C. Stanford, a practical chemist, distinguished for the introduction of several original methods of manufacture, and for the preparation

of several new substances, such as algin and thyroglandin; he was the author of the monograph on the iodine industry in Thorpe's Dictionary of Chemistry; and John Ruskin, who, though not a man of science in the strict sense of the term, did his full share for the advancement of knowledge and comfort among men, at Coniston Lake, England, January 20th, in his eighty-first year.

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Carter, Oscar C. S. Coastal Topography of the United States. Pp. 30.

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Densmore, Emmet, M. D. Consumption and Kindred Diseases. (Open-air Treatment.) Brooklyn, N. Y.: The Stillmann Publishing Company. Pp. 138.

Douglas, James, New York City. American Transcontinental Lines. Pp. 56.

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McKay, A. H., Halifax, Nova Scotia. Phenological Observations, Canada, 1898. Pp. 20.

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Peet, Stephen Denison. The Cliff-Dwellers and the Pueblos. Chicago: Office of the American Antiquarian. Pp. 398.

Smithsonian Institution. List of Publications available for Distribution. December, 1899. Pp. 35.

Sound Currency. October, 1899. Deposit Currency; the Effective Currency of Commercial Communities. Pp. 12. November, 1899. The Farmer's Interest in the Banking Question. Pp. 8. Both by L. Carroll Root.

Spencer, Frank Clarence. Education of the Pueblo Child. A Study in Arrested Development. (Columbia University Contributions to Philosophy, Psychology, and Education. Vol. VII, No. 1.) New York: The Macmillan Company. Pp. 97. 75 cents.

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United States Commissioner of Fish and Fisheries. The Preservation of Fishery Products for Food. By Charles H. Stevenson. Pp. 570.

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RECENT YEARS OF EGYPTIAN EXPLORATION.

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FAMILIAR as we are with the methods of science—exact observation and record, comparison, and the strict weeding out of hypotheses—yet such methods have only gradually been applied to various branches of learning.

Geometry became a science long ago, zoölogy much later, medicine only a generation or two ago, and the history of man is but just being developed into a science. What was done for other sciences by the pioneers of the past is now being done in the present day for archæology. We now have to devise methods, to form a notation for recording facts, and to begin to lay out our groundwork of knowledge. With very few exceptions, it may be said of Egypt that there is no publication of monuments before this century that is of the least use, no record or dating of objects before 1860, and no comparison or study of the history of classes of products before 1890. Thus, the work of recent years in Egyptology is really the history of the formation of a science.

The great stride that has been made in the last six years is the opening up of prehistoric Egypt, leading us back some two thousand years before the time of the pyramid builders. Till recently, nothing was known before the age of the finest art and the greatest buildings, and it was a familiar puzzle how such a grand civilization could have left no traces of its rise. This was only a case of blindness on the part of explorers. Upper Egypt teems with prehistoric remains, but, as most of what appears is dug up by plunderers for the market, until there is a demand for a class of objects, very

little is seen of them. Now that the prehistoric has become fashionable, it is everywhere to be seen. The earlier diggers were dazzled by the polished colossi, the massive buildings, the brilliant sculptures of the well-known historic times, and they had no eyes for small graves, containing only a few jars or, at best, a flint knife.

The present position of the prehistory of Egypt is that we can now distinguish two separate cultures before the beginning of the Egyptian dynasties, and we can clearly trace a sequence of manufactures and art throughout long ages before the pyramid builders, or from say 6000 B. C., giving a continuous history of eight thousand years for man in Egypt. Continuous I say advisedly, for some of the prehistoric ways are those kept up to the present time.

In the earliest stage of this prehistoric culture metal was already used and pottery made. Why no ruder stages are found is perhaps explained by the fact that the alluvial deposits of the Nile do not seem to be much older than eight thousand years. The rate of deposit is well known—very closely one metre in a thousand years—and borings show only eight metres thick of Nile mud in the valley. Before that the country had enough rain to keep up the volume of the river, and it did not drop its mud. It must have run as a rapid stream through a barren land of sand and stones, which could not support any population except paleolithic hunters. With the further drying of the climate, the river lost so much velocity that its mud was deposited, and the fertile mud flats made cultivation and a higher civilization possible. At this point a people already using copper came into the country. Their bodies were buried in shallow, circular pit-graves, covered with goat skins, which were fastened rarely by a copper pin; before the face was placed a simple bowl of red and black pottery, and some of the valued malachite was placed in the hands. The body was sharply contracted, often with the knees almost touching the face, and the hands were usually in front of the face.

Very soon they developed their pottery into varied and graceful forms, and decorated it with patterns in white clay applied to the dark-red surface, but it continued to be entirely hand-made, without the use of the potter's wheel. The patterns, usually copied from basketwork, show the source of the forms of the cups and vases. The modern Kabyle, in the highlands of Algeria, has kept up the same patterns on hand-made pottery, and the same use of white clay on a red base. It is probably to a Libyan people that this civilization is first due, and the skulls of these prehistoric Egyptians are identical with those of the prehistoric Algerians from the dolmens and the modern Algerians. This first growth of the civilization not only developed pottery, but also the carving of stone

vases entirely by hand. The principal type of these is the cylinder, with many small variations. Figures were carved in alabaster and bone, and modeled in clay and paste; these are rude, but show that the type of the race was fine, with a high forehead and pointed beard. The use of marks denoting property was common, and such marks seem to be the earliest stages of the system of signs which developed later into the alphabet. This civilization had apparently passed its best time, decoration had ceased on the pottery, when a change came over all classes of work.

The second prehistoric civilization seems to have belonged to a people kindred to that of the first age, as much of the pottery continued unchanged, and only gradually faded away. But a new style arose of a hard, buff pottery, painted with patterns and subjects in red outline. Ships are represented with cabins on them, and rowed by a long bank of oars. The use of copper became more general, and gold and silver appear also. Spoons of ivory, and rarely of precious metals, were made, but hair combs, which were common before, ceased to be worn. Stone vases were commonly carved in a variety of hard and ornamental stones, but always of the barrel outline and not the early cylinder shapes. Flint-working reached the highest stage ever known in any country, the most perfect mastery of the material having been acquired. Though this civilization was in many respects higher than that which preceded it, yet it was lower artistically, the figures being ruder and always flat, instead of in the round. Also the use of signs was driven out, and disappeared in the later stage of this second period. The separation of these two different ages has been entirely reached by the classification of many hundreds of tombs, the original order of which could be traced by the relation of their contents. In this way a scale of sequence has been formed, which enables the range of any form of pottery or other object to be exactly stated, and every fact of connection discovered can be at once reduced to a numerical scale as definite as a scale of years. For the first time a regular system of notation has been devised for prehistoric remains, and future research in each country will be able to deal with such ages in as definite a manner as with historic times. The material for this study has come entirely from excavations of my own party at Nagada (1895), Abadiyeh, and Hu (1899); but great numbers of tombs of these same ages have been opened without record by M. de Morgan (1896–'97), and by French and Arab speculators in antiquities.

The connection between these prehistoric ages and the early historic times of the dynastic kings of Egypt is yet obscure. The cemeteries which would have cleared this have unhappily been

looted in the last few years without any record, and it is only the chance of some new discoveries that can be looked to for filling up the history. We can at least say that the pottery of the early kings is clearly derived from the later prehistoric types, and that much of the civilization was in common. But it is clear that the second prehistoric civilization was degrading and losing its artistic taste for fine work before the new wave of the dynastic or historic Egyptians came in upon it.

These early historic people are mainly known by the remains of the tombs of the early kings, found by M. Amelineau at Abydos (1896–'99), and probably the first stage of the same race is seen in the rude colossi of the god Min, which I found at Koptos (1894). Unhappily, the work at Abydos was not recorded, and it is not known now out of which of many kings' tombs, nor even out of which cemeteries, the objects have come. Hence scientific results are impossible, unless enough material has escaped the careless and ignorant workmen to reward more accurate reworking of the same ground. We can at present only glean a general picture of the early royal civilization from Abydos, supplemented by some splendid carvings of two reigns found at Hierakonpolis (1897–'98) by Mr. Quibell.

The burials continued to be in tombs of the same form—rectangular pits lined with brickwork and roofed over with beams and brushwood. But they were made larger, and, in the case of the royal tombs, great halls were formed about fifty by thirty-five feet, roofed with beams eighteen or twenty feet long. In these royal tombs were placed a profusion of vases of hard and beautiful stones, bowls of slate, and immense jars of alabaster; these contained the more valuable offerings of precious ointments and other funereal treasures. Besides these, there were hundreds of great jars of pottery, containing provision of bread, meats, dried fruits, water, beer, and wine. Doubtless there were many vases of metals, but these have been almost always robbed from the tomb anciently. Around the tomb were the small graves of the retainers of the king, each with a lesser store like that of their master. The royal tomb was denoted by a great tablet bearing the king's spiritual name by which he would be known in the future world. The private tombs had small tablets, about a foot and a half high, with the names of their occupants. As all these tablets show considerable weathering, it seems that they were placed visible above the tomb. Tombs of the subsequent kings were elaborated with small chambers around the great one, to contain the offerings, and even a long passage was formed with dozens of chambers along each side of it, each chamber containing a separate kind of offering.

Turning now to some of the remains of these kings during their life, we learn that they were occupied with frequent wars—the gradual consolidation of the kingdom of Egypt. One king will record the myriads of slain enemies, another gives a picture of a captive king brought before him with over a million living captives, the regular Egyptian notation for such large numbers being already complete. Another king shows his triumphal entry to the temple, with the slain enemies laid out before him. On other sculptures are shown the peaceful triumphs of canalization and reclamation of land, which are alluded to in the traditions of the early dynasties preserved by Greek historians. All these scenes are given us on the slate carvings and great mace heads covered with sculpture from Hierakonpolis.

Thus in these great discoveries of the last few years we can trace at least three successive peoples, and see the gradual rise of the arts, from the man who was buried in his goat skins, with one plain cup by him, up to the king who built great monuments and was surrounded by most sumptuous handiwork. We see the rise of the art of exquisite flint flaking, and the decline of that as copper came more commonly into use. We see at first the use of signs, later on disused by a second race, and then superseded by the elaborate hieroglyph system of the dynastic race.

The mixture of various races was surmised long ago from the varied portraiture of the early times. It is now shown more plainly than ever on these early monuments. We see represented the king of the dynastic type, a scribe with long, wavy hair, a chief of the dynastic shaven-headed type, another with long, lank hair, and another with a beard, while the enemies are shown with curly hair and narrow beards like Bedouin. Four different peoples are here in union against a fifth. And this diversity of peoples lasts on long into the historic times. After several centuries of a united Egypt, under the pyramid builders, we find that some people buried in the old contracted position, others cut up the body and wrapped every bone separately in cloth, while others embalmed the body whole. Thus great diversity of belief and custom still prevailed for perhaps a thousand years after the unification of Egypt. So useless is it to think of "the ancient Egyptians" as an unmixed race gradually rising into "a consciousness of nationality."

The excavations at Deshasheh in 1897, which first showed me the diversity of burials, also showed that the type of the race had already become unified by intermixture, and that, strange to say, four thousand years later, after untold crossings with many invaders, the type was unchanged. Later work at Dendereh and elsewhere has pointed to the conclusion that a mixture of a new

race is subdued to the type of the country by the effect of climate and surroundings within a few centuries.

Turning now to the purely classical Egyptian work, the principal discoveries of the last few years have given us new leading examples in every line. The great copper statue of King Pepy, with his son, dates from before 3000 B. C. It is over life size, and entirely wrought in hammered copper, showing a complete mastery in metal work of the highest artistic power. Probably of the same age is a head of a figure of the sacred hawk, wrought hollow in a single mass of hammered gold, weighing over a pound; this again shows work of noble dignity and power. Both of these were found at Hierakonpolis in 1898, and are now in the Cairo Museum.

Some centuries later was made the exquisite jewelry found at Dahshur in the graves of three princesses. This is a revelation of the delicacy possible in goldsmith's work. The soldering of the minute parts of the gold is absolutely invisible. The figures of hawks are made up of dozens of microscopic pieces of colored stone —lazuli, turquoise, carnelian—every one cut to the forms of the feathers, and every piece having a tiny cell of soldered gold strip to hold it in place, yet the whole bird only about half an inch high. The finest colored enameling ever made would be child's play compared with a piece of this early jewelry. The exquisite grace of form, harmony of coloring, and sense of perfection leave the mind richer by a fresh emotion, after seeing such a new world of skill. Coming down to about 1500 B. C., a large work has been done in the last six years in clearing the temple of Queen Hatshepsut at Deir el Bahri, on the western side of Thebes. That great ruler had there commemorated the events of her reign, particularly the expedition to the south of the Red Sea to obtain the plants of the sacred incense and other valued products. The attention shown to exact figuring of plants and animals makes this valuable as a record of natural history. This clearance has been made by Dr. Naville for the English fund. Meanwhile, Franco-Egyptian officials have been clearing out the Temple of Karnak, on the opposite bank, but with disastrous effect. The huge columns, built poorly of small blocks by Rameses II, stand now below the level of the inundation, and, after removing the earth accumulated around them, the Nile water has free circulation. This has dissolved the mortar so much that nine of these Titanic columns of the Great Hall fell last year, and three more threaten to follow them.

The Valley of the Tombs of the Kings has been prohibited ground to foreign explorers for over forty years, although the official department never did any work there. The native plunderers, however, turned up many years ago the beautiful chair

of Queen Hatshepsut, and lately they found the entry to still unopened royal tombs. The secret passed—for a consideration—to the Department of Antiquities, and two royal tombs were opened. These contained the bodies of several kings of the eighteenth and nineteenth dynasties—one undisturbed, the others moved from elsewhere. With these was a crowd of objects of funereal furniture. Unhappily, nothing is published in detail of any official discoveries; with the exception of the first find of the Dahshur jewelry, there has never been any full account issued of the great discoveries in the most important sites, which are reserved to the Government. The great group of kings found at Deir el Bahri, the great necropolis of the priests of Amen, the second find of Dahshur jewelry, the second group of royal mummies, of all these we know nothing but what has appeared in newspapers, or some partial account of one branch of the subject. Hardly any publication has ever appeared, such as the English societies issue every year about the produce of their excavations.

Many of the royal temples of the nineteenth dynasty at Thebes were explored by the English in 1896. The Ramesseum was completely examined, through all the maze of stone chambers around it. But the most important result was the magnificent tablet of black granite, about ten feet high and five wide, covered on one side with an inscription of Amen Hotep III, and on the other side with an inscription of Merenptah. The latter account, of about 1200 B. C., mentions the war with the "People of Israel"; this is the only naming of Israel on Egyptian records, and is several centuries earlier than any Assyrian record of the Hebrews. It has, of course, given rise to much discussion, which is too lengthy to state here.

One of the most important results of historical Egyptian times is the light thrown on prehistoric Greek ages. The pottery known as "Mykenæan" since the discoveries of Schliemann in the Peloponnesus was first dated in Egypt at Gurob in 1889; next were found hundreds of vase fragments at Tell el Amarna in 1892; and since then several Egyptian kings' names have been found on objects in Greece, along with such pottery. The whole of this evidence shows that the grand age of prehistoric Greece, which can well compare with the art of classical Greece, began about 1600 B. C., was at its highest point about 1400 B. C., and became decadent about 1200 B. C., before its overthrow by the Dorian invasion.

Besides this dating, Greece is indebted to Egypt for the preservation of the oldest texts of its classics. Fragments of Plato almost contemporary with his lifetime, pages of Thucydides, whole books of the Iliad, and the celebrated recent publications of Bacchylides

and Herondas, all are due to Egypt. Moreover, of Christian times we have a leaf of an early collection of Sayings of Jesus, a leaf of gospel about two centuries older than any other biblical manuscript, and a host of documents bearing on early Christianity, such as the Gospel of Peter and other apocryphal writings which were later banned by the Church.

Now it may be asked how all these discoveries are made—indeed, many people take for granted that some government kindly pays for it all. On the contrary, the only official influences are a severe check on such scientific work. While a native Egyptian can plunder tombs with but little hindrance, any one desiring to preserve objects and promote knowledge must (after obtaining the permission of the Egyptian Government for the exact place he wants to work) be officially inspected at his own expense (a matter of twenty or thirty pounds a season), and then, after all, give up to the Government half of all he finds, without any recompense. The English Government long ago gave up all claim for British subjects to occupy any post in the Cairo Museum, thus putting a decisive bar on the hopes of would-be students and hindering the object very effectually.

In face of all these disadvantages, work has yet been carried on by the Egypt Exploration Fund and by the Egyptian Research Account; both rely on English and American support, and the latter body is intended expressly to help students in training. Besides these, private work has been carried on during several years by two or three other explorers, partly at their own cost, partly helped by friends. The two societies above named have kept to the principles that everything shall be published as soon as possible, and that all the antiquities removed from Egypt shall be divided among public museums as gifts in return for the support from various places, nothing ever being sold publicly or privately. In this way several centers in America send large annual contributions, have representatives on the London Committee of the Exploration Fund, and receive their share for museums every year.

Besides this organizing of ways and means, there is quite as important organization needed in the excavations. At present most of the above-named work is done by a corps of men who have been engaged at it for many years. They leave their homes and assemble as soon as the winter begins; any dealing in antiquities or misconduct since the last season excludes them from rejoining. They each know their work, what to preserve, how to leave everything intact in the ground where found, and how best to manage different kinds of excavating. With such men it is always possible to screw more information out of a site, however much it may

have been already wrecked in ancient or modern times. And it is far safer to leave such men unwatched, with the certainty that they will receive a fair value for all they find, than it is to drive a gang under the lash, on bare wages, without rewards to keep them from pilfering. The English system means mutual confidence and good faith; the native and French system of force means the destruction of both information and antiquities.

And yet besides this there is the essential business of observing and recording. Every hole dug must have a meaning and be understood, as to the date of the ground at different levels and the nature of the place. Everything must be spelled out as the work advances; any difficulties that can not be explained must be tried with all possible hypotheses; each detail must either fall into place as agreeing with what is known, or be built in as a new piece of knowledge.

Twenty years ago nothing was known of the date of any Egyptian manufactures, not even of pottery or beads, which are the commonest. Now, at present it is seldom that anything is found which can not be dated tolerably near by, and in some classes of remains the century or even the reign can be stated at once, without a single word to show it. The science of Egyptian archæology is now in being.

In this, therefore, as in many other matters, the Anglo-Saxon taste for private enterprise is the ruling power, and in spite of political obstacles and of taxation, which are happily unknown in other sciences, the private work of individuals has quietly traced out the foundations of one of the earliest civilizations of mankind.

THE GOLD SANDS OF CAPE NOME.

By Prof. ANGELO HEILPRIN,
LATE PRESIDENT OF THE PHILADELPHIA GEOGRAPHICAL SOCIETY.

ONE of the most interesting contributions to the history of gold and gold mining has undoubtedly been discovered in the region of Cape Nome, Alaska, during the past summer. Vague reports have from time to time, for a period of a year or more, been sent out from the bleak and inhospitable shores of Bering Sea of the discovery there of rich deposits of placer gold, and of almost fabulous wealth acquired by a few fortunate prospectors—a new Klondike on American soil—but these gained little credence beyond the portals of transportation companies and the organizers of "boom" enterprises. A few of the more credulous and those unmindful of adventure and hardship took practical action on the

receipt of the reports, and prepared to buffet the still ice-bound waters of the Pacific to gain early access to the new land of promise. In a brief period the fame of Golovnin Bay had been spread broadcast, only to be again dimmed by the later announcements that the earlier reports of finds were only "fakes." Making and unmaking

An Off-Shore View of Nome.

are a part of all new mining centers, and in an incredibly short time all manner of conclusions are arrived at regarding the possibilities of a location.

New reports of finds made along the coast of Bering Sea, about fifty miles west of Golovnin Bay, called renewed attention to the region, and those who in the early summer of the past year (1899) timidly ventured their fortunes to share in a possible discovery, found, on their arrival at the tundra-bound shores about Cape Nome, that miles of territory had already been located as claim sites, that sluice-boxes were in full operation, and that sackfuls of gold dust and nuggets had been carefully laid to one side, representing "outputs" of tens of thousands of dollars. At this time many of the journals of civilization in the East, repeating the warnings that they persistently threw out following the discovery of gold in the Klondike, jealously guarded the secrets of the earth by doubting, or even denying, the claims to discovery, but, withal, wisely counseling against that haphazard and purseless rush which is one of the invariable accompaniments of gold announcements. A new mining district had suddenly sprung into existence, and before two months had passed—i. e., by the early days of Sep-

tember—a full front of tents and frame houses took possession of what continues to remain a dreary and desolate expanse of ocean beach—sufficiently pleasant in the quiet, balmy days of summer and autumn, but wofully exposed to the hurricane blasts of the arctic winter—and gave shelter to from three to four thousand adventurers, where formerly a few Indians and Eskimos from the still farther northwest and King's Island constituted a straggling and accidental population. This, in brief, is the initial history of the Nome or Anvil City mining region, which will almost certanly call to it in the coming spring fifteen to twenty thousand additional inhabitants.

Far more interesting to the one who has not been properly rewarded in his search for placer claims than the placer deposits themselves are the gold-bearing beach sands, whose productivity will mainly be responsible for the influx of population to the new region. From them, by crude and simple methods, has been taken, in barely more than two months, gold to the value of more than a million dollars, and what the possibilities for the future may be

A Street in Nome.

no one is wise enough to tell. So clearly exaggerated did the accounts of the free-sand rocking appear, even those coming from reputable miners who were personally known to me, that I could hardly bring myself to take them at their full value, but, being accidentally drifted in the course of a summer's wanderings to St.

Michael, above the mouth of the Yukon River, I had easy opportunity to verify for myself the accuracy of the statements that had been sent out, and to cast a geological glance at the situation. My examination of the region was confined to a few of the later days of September and to early October.

The geographical position of the Nome region is the southern face of the peninsular projection of Alaska which separates Kotzebue Sound on the north from Bering Sea on the south, and terminates westward in Cape Prince of Wales the extent of the North American continent. In a direct line of navigation, it lies about twenty-five hundred miles northwest of Seattle and one hundred and seventy miles southeast of Siberia. The nearest settlement of consequence to it prior to 1899 was St. Michael, a hundred miles to the southeast, the starting point of the steamers for the Yukon River; but during the year various aggregations of mining population had built themselves up in closer range, and reduced the isolation from the civilized world by some sixty miles. The Nome district as settled centers about the lower course of the Snake River, an exceedingly tortuous stream in its tundra course, which emerges from a badly degraded line of limestone, slaty, and schistose mountain spurs generally not over seven hundred to twelve hundred feet elevation, but backed by loftier granitic heights, and discharges into the sea at a position thirteen miles west of Cape Nome proper. Three miles east of this mouth is the discharge of Nome River. Both streams have a tidal course of several miles. Nome, or, as it was first called, Anvil City—named from a giant anvil-like protrusion of slate rock near to the summit of the first line of hills—occupies in greater part the tundra and ocean beach of the eastern or left bank of Snake River, but many habitations, mainly of a temporary character, have been placed on the bar beach which has been thrown up by the sea against the mouth of the stream, and deflected its course for some distance parallel with the ocean front. A number of river steamers (one even of considerable size) and dredges have found a suitable anchorage or "harbor" in the barrier-bound waters, and much driftwood passes into them at times of storms and higher waters, when the greatly constricted and shallow mouth is made passable. The entire region is treeless, and the nearest approach to woodland is in the timber tract of Golovnin Bay and its tributaries, about forty miles to the northeast. A fairly dense growth of scrub willow, three to five feet in height, with elms and alders, forms a fringe or delimiting line to parts of the courses of the streams in the tundra, which greatly undulates in the direction of the foothills and incloses tarnlike bodies of fresh and slightly brackish waters. It is covered merely with a

low growth of flowering herbaceous plants, grass, and moss, with a somewhat scantier admixture of the dwarf birch, arctic willow, and crowberry. The surface is pre-eminently swampy during the warmer periods of the year, and walking over it means either wading through the water or risking continuous jumps to and from the individual clumps of matted grass and moss—the so-called "nigger-heads." The greater part of the tundra seems to rest on gravel and sand—doubtless of both marine and fluviatile origin—and ordinarily the frozen stratum is already reached at a

A Native of the Land of Nome.

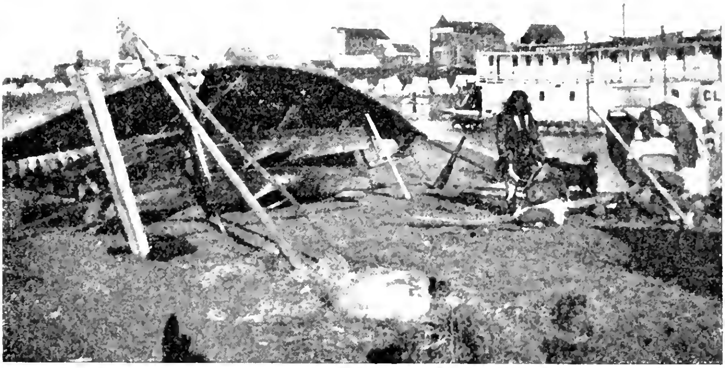
depth of two or three feet, sometimes less. In early October of the past year it was still too "open" to permit of easy walking over it, but in quite early hours of the morning the surface afforded fair lodgment to moderate weights. Fragmentary parts of the skeleton of the mammoth have been found here and there, even loose on the top grass, but where found in such situations it is by no means certain that they had not been redeposited by high tidal wash. A large fragment of thigh bone, with shoulder blade, which I found about an eighth of a mile inland and perhaps

fifteen feet above the water, was associated with one of the mandibular bones of the whale. I could obtain no information as to their having been possibly carried to their present position by man, but it may have been the case. A large skull, which I owe to the kindness of Mr. Inglestadt and to Mr. Louis Sloss, Jr., manager of the Alaska Commercial Company, was obtained, as nearly as I could determine through inquiry on the spot, from about the same locality. Where it abuts upon the sea the tundra stands from eight to twenty feet above it, at places descending to even lower levels. The sea face is almost everywhere an abrupt one, showing undercutting by high water, and it is continued by a broad, rapidly sloping sand and shingle beach, which packs firmly, and almost immediately beneath the surface exhibits a distinctly stratified construction—the alternate layers of fine, flat gravel, coarse, clayey sand, and finer "ruby" (fragmented garnet) sand sloping like the surface, although generally with a milder pitch, to the sea.

The open sea front, with inland tundra, is continued for a distance of about fourteen miles westward of Nome, where it is interrupted by the mountains, in a west-southwest course, reaching the sea; flat-topped Sledge Island, so much recalling in aspect some of the islands lying off Whale Sound, in the northwest of Greenland, is their oceanic continuation for some distance, with sharp breaks on both the oceanic and inner sides. It is probable that much of the *débris* that has resulted from the disruption of the mountain masses has been distributed littorally by the sea, with an eastward wash, to form the bars and shallows which for some distance stretch along the coast; nor is it impossible that some of the giant bowlders of limestone, marble, granite, and syenite which are found on the margin of the beach about four or five miles west of Nome, some of them measuring eight and twelve feet or more in diameter, and all of them smoothly rounded and evenly polished, represent a part of this destruction. At the same time, there is good reason to suspect that they may have been deposited by ice action, either as erratics of floe ice coming from the northwest, or of glacial distribution from the region of the mountains. Whatever may have been the final stage in the history of the amphitheater of Nome (the region included between Cape Nome and Sledge Island), which my limited observation did not permit me to determine to full satisfaction, it is almost certain, even in the absence of the ordinary glacial testimony, that the region is one of past glaciation, and that much of the gravel and bowlder material of the ocean front is of morainic origin, so modified and altered in position by readjustments of the land and water as to have lost its proper physiographic contours. The aspect of the hills and valleys is almost precisely

that of some of the regions of Greenland which have only quite recently been vacated by the glaciers, while the composition of the shingle—the inclusion over so long a front of bowlders from beyond the first line of mountain heights, many of them most markedly grooved and polished—is also highly suggestive of glacial deposition.

The gold sands, or sands that are worked for gold, are merely the ordinary materials of the beach, loose and incoherent like most seashore sands, and particularly defining horizons three to six feet below the surface. In regular stratified layers, with fine and moderately coarse gravel, they embrace four or five distinct layers of fragmented garnets (the components of the so-called "ruby sand"), and it is from these, and at this time almost exclusively from the



The Harbor of Snake River (Nome).

bottom layer of three to five inches thickness, which is popularly described as lying on "bed rock"—in most places merely a hard-pan of arenaceous clay or argillaceous sand, with no true rock to define it—that most of the gold is obtained. Each ruby band nearer to the top seems to contain less and less gold, and there is no question that the different layers are merely reformations by the sea from those of earlier deposition, just as surface shingle deposits generally are in part reconstructions of underlying beds. That the ocean is to-day depositing the ruby sand is unmistakably shown by the great patches of this sand lying on the surface and its incoming in the path of nearly every storm. Even these surface sands are mildly gold-bearing, showing that the gold, despite its high specific gravity, may be buoyed up and wafted in by such a

light medium as water when it has been reduced to sufficiently minute particles or scalelike forms. It is little wonder that a general belief has gained currency with the more enthusiastic locators that the sand gold is a deposition or precipitate from the sea.

The gold itself occurs in an exceedingly fine state of subdivision, too fine in most cases to be caught without mercury or the best arrangement of "blanketings." Much of it is really in the condition of colors dissected nearly to their finest particles, and it is hardly surprising that it should have so long escaped detection. Occasionally pieces to the value of three to six cents are obtained in the pans, and I was witness to the finding of a scale with the value of perhaps nearly twenty cents. The usual magnetitic particles are associated with the gold, and their origin can clearly be traced to the magnetite which is so abundantly found in some of the schists (micaceous, chloritic, and talcose schists), which, judged by the fragments and bowlders that everywhere lie in the path of the streams of the tundra, must be closely similar to the series of schists of the Klondike region. The particles of fragmented garnet, which by their astonishing abundance give so distinctive a coloring to the layers which they compose or constitute, are of about the ordinary fineness of seashore sand, perhaps a trifle coarser, but occasionally much coarser particles or masses of particles are found; and in the placer deposits of Anvil Creek, as in the bunch of claims around "Discovery"—about five miles due north of Nome—fragments of the size of lentils are not uncommon. I have seen full garnets obtained from the wash here which were of the size of small peas. Nodules of manganese (manganite, pyrolusite) are at intervals found with them, and some stream-tin (cassiterite), as in the Klondike region, also appears to be present. Apart from the evidence that is brought down by the magnetite and garnet, it would naturally be assumed that the gold had its primal source in the mountains back of the coast. These, as has already been stated, have undergone exhaustive degradation, and the materials resulting from their destruction, in whatever way brought about, have been thrown into the sea, and there adjusted and readjusted—or, so far as the gold particles are concerned, one might say "concentrated." Latterly, and perhaps this is also true to-day, the land has undergone elevation, and exposed much that until recently properly belonged to the sea. The tundra is a part of this ocean floor, and it too doubtless contains much gold, perhaps even very much.

The length of the sea strip that was worked during the past summer, and so far in autumn as the clemency of the weather permitted, covered a nearly continuous thirty or thirty-five miles,

extending beyond Synrock on the west and, with interruptions, to Nome River on the east. The full extent of the auriferous sands remains unknown, however, and report claims for them reappearances throughout the entire coast as far as Cape Prince of Wales. The season's work gave easy and lucrative employment to perhaps fifteen hundred, mostly needy, prospectors, who realized on an average certainly not less than fifteen dollars per day, and many as much as sixty, seventy, and eighty dollars. It is claimed, and I have little reason to doubt the truthfulness of the statement, that from a single rocker, although operated by two men, one hundred and fifty dollars had been taken out in the course of nine hours' work. It is also asserted that two men realized a fortune of thirteen

Erecting a Steam Pump (Nome).

thousand dollars as the result of their combined season's work, and two others are said to have rocked out forty-five hundred dollars in the period of a month. Women have, to an extent, shared with men the pleasures of "rocking gold from the sea," and their application in the toils of the sea plow, with booted forms, rolled-up sleeves, and sunbonnets, was certainly an interesting variation on the borders of the Arctic Circle from the scenes one has grown accustomed to at Atlantic City or Newport.

The placer deposits of the Nome district are in the form of shallow, largely or mostly unfrozen gravels, which occupy varying heights, partly in disrupted or overhanging benches, of the valleys and gulches which trench the slate and limestone mountains. Perhaps the most favored ones are those of Anvil and

Glacier Creeks (with Snow Gulch as an affluent of the latter), tributaries of Snake River, and Dexter Creek, a tributary of Nome River. My time and the conditions of weather permitted only of a visit to Anvil Creek, and an examination mainly of the properties about "Discovery." The diggings here are all shallow, from four to seven feet, when bed-rock, a steeply pitching and highly fissile slate, is reached. As before remarked, the gravels are not frozen, and thereby present a marked contrast to the condition that prevails in the Klondike region, and one, it is hardly necessary to state, which is eminently to the favor of economy in mining. A layer of ice, about eight inches in thickness, covers one side of the layers in claim "No. 1 below," but beneath this the matrix is

"Digging" the Seashore Sands for Gold.

again open. In all these claims the pay-streak was at first reported to be very broad, but it seems that the later work has narrowed down the probabilities of extension very measurably—at any rate, in the condition of a rich producer. Of the wealth contained in these claims there is no question, but it would probably be straining the truth to say that it is the equal of that of the best or even the better claims of the Klondike region. A two days' clean-up from "No. 1 below" is reported to have yielded thirteen thousand dollars, while the entire product of that claim from July 26th, when the first wash was made, to September 21st, was placed at one hundred and twenty-five thousand dollars. Claim "No. 1 above" appears to be equally good, and "Discovery" falls perhaps not very far below either. A nugget of the value of three hun-

dred and twelve dollars—a magnificent specimen, measuring upward of four inches in length—was obtained from the tailings of "No. 1 below"; a larger one, of the value of four hundred and thirty-four dollars, is to the credit of "No. 1 above." It is interesting to note that these rich claims are located at the very issuance of Anvil Creek from the mountains—i. e., at the contact with the upper rise of the tundra—and other good properties are found still lower down, a condition which makes it certain that the inner reaches of the tundra, whatever the whole tundra may be, must yield largely in gold.

The city of Nome itself might properly be termed a model of production. Before the end of June, 1899, there was practically nothing on its present site; in early July it was still a place of tents, but by the middle of September it had blossomed out into a constructed town of three to four thousand inhabitants, more than one half of whom were properly housed in well-built cabins, the lumber for which was in part brought from a distance of two thousand miles, and none of it from less than one hundred miles. Numerous stores and saloons had arranged themselves on both sides of a well-defined street (which was here and there centrally interrupted by building transgressions), the familiar signs of dancing and boxing bouts were displayed in front of more than comfortably filled faro and roulette establishments, and in a general way the site wore the aspect of riding a boom swell. And indeed there was plenty of activity, for the final weeks of fine weather warned of the impending wintry snows and blasts, and much had to be done individually to shield one from these and other discomforts. There was at that time a threatening shortage in building material, and fears were expressed for those who seemingly would be obliged to spend the winter months—a dreary expanse of nearly one half the year, with hurricane blasts of icy wind blowing with a velocity of fifty to eighty miles an hour, and under the not very comfortable temperature of $-40°$ to $-60°$ F.—in the frail shelter of tents. How many, if any, remained in this condition can not now be known. Much driftwood and some coal had been secured by many of the more fortunate inhabitants, and it is possible that some provision has been made by which everybody of the two or three thousand wintering inhabitants will receive a proper measure of heating substance, without which the utmost discomfort must prevail. The last coal before my departure sold for seventy-five dollars per ton, but I suspect that later importations must have realized the better part of double this amount. In early October flour could still be purchased for seven to eight dollars per sack, and meat for a dollar a pound, but these prices

were run up very materially in the period of the next two weeks. Good meals were only a dollar, and fractions of meals could be had for twenty-five and fifty cents. Magnificent oranges were only a quarter apiece, and watermelons four and five dollars. All these prices were, at the least, doubled before the first week in November, when the locality was finally cut off from contact with the rest of the civilized world. The principal commercial houses doing trade in Alaska—as the Alaska Commercial Company, the North American Trading and Transportation Company, the Alaska Exploration Company, all of which, besides others, have their agencies in Dawson and at various stations on the Yukon River—have well-constructed, iron-sheathed warehouses, and carry large lines of goods. The energy which in so short a period has planted these interests here, and in so substantial a manner, is certainly astonishing. Who a year ago could have expected that the needs of a resident population situated close under the Arctic Circle, and along the inhospitable shores of Bering Sea, would have demanded depots of sale of the size of those that one finds in cities of importance in the civilized South?

Nome prints to-day three newspapers, the first issue of the first journal, the Nome News, appearing about the 10th of October. Its selling price was twenty-five cents. Up to the time of my leaving, there were no serious disturbances of any kind, but indications of trouble, resulting from the disputed rights of possession, whether in the form of squatter sovereignty or of purchase, were ominously in the air, and it was feared that should serious trouble of any kind arise, neither the military nor civil authorities would be in a position to properly cope with it. It was freely admitted that the community was not under the law that so strongly forces order in Dawson and the Klondike region. Much more to be feared than disturbance, for at least the first season, is the possibility of conflagration; closely packed as are the tents and shacks, with no available water supply for combating flames, a headway of fire can not but be a serious menace to the entire location, and one which is in no way lessened through the general indraught of hurricane winds. The experiences of Dawson should have furnished a lesson, but they have seemingly not done so, nor has apparently the average inhabitant profited in any effort to ward off the malignant influences arising from hard living, unnecessary exposure to the inclemencies of the weather, and a non-hygienic diet. Hence, typhoid or typho-malarial disease, even if not in a very pronounced form, has already sown its seeds of destruction, and warns of the dangers which here, as in Dawson, man brings to himself in his customary contempt for the working of Nature's laws.

A STATE OFFICIAL ON EXCESSIVE TAXATION.

By FRANKLIN SMITH.

IT is not to government reports that a student of social science looks for warnings against the perils lurking in the enormous expenditures and the extraordinary enlargement of the duties of the state. Officials are usually so deeply impressed with the importance of their positions and so anxious to magnify the worth of their labors that they are prone to take the rosiest view of any part of the great clanking machine intrusted to their care. With the keenest pride they point to their achievements in furthering the work of human welfare. If modesty does not restrain them, they are certain to paint, with an artless faith in their own abilities, the still greater work that could be done with a slight increase of funds and a little more assistance. Not all officials, however, permit themselves to indulge in the natural vanity of bureaucrats. They refuse either to be blinded to the perpetual failure of state-made civilization, or to deceive the impoverished victims of the same costly system of modern magic. Of the very few of this class Mr. James H. Roberts, for five years Comptroller of the State of New York,* is perhaps the most conspicuous. Astray as he is on the question of a graded inheritance tax, and trustful as he is in the virtue of State supervision, he puts himself beyond criticism in his opposition to the policy of State socialism, now the rage at home and abroad. Indeed, no one could hold it up to graver reproach.

Whenever an observer of the signs of the times in the United States ventures to say that they offer little food for hope, he is branded as pessimistic or unpatriotic. He is told that if he had the confidence in democratic institutions of a man with a good digestion and a fair intelligence, he would know that they possess a vitality, a power of rejuvenation, that does not belong to an autocracy nor an aristocracy. If he is particularly despondent, and seeks to justify himself with fact and argument, he is denounced as a dangerous agitator, or, what is a shade more odious, as an absurd *doctrinaire.* But Mr. Roberts has not been consigned to any such depths of contempt. He is known as a "hard-headed business man," a title of honor that always frees the most ridiculous optimist from any suspicion of the theorist or sentimentalist. Yet, as the supervisor of the finances of a great State, he was brought in contact with a mass of phenomena that forced upon him the conviction that something is wrong, and that if it is not

* He was in office from January 1, 1894, to January 1, 1899.

righted it will bring disaster. Indeed, I do not recall a pessimist, however dyspeptic, nor a *doctrinaire*, however visionary, that has struck a more melancholy note than he. In all his reports much will be found that indicates anything but a belief that a democracy that plunders and enslaves a people is any better than any other despotism guilty of the same offense, or that the practice in the one case will be productive of greater prosperity and happiness than in the other.

It is, however, in the report for 1897 that Mr. Roberts gives the fullest expression to his apprehensions. "This country," he says in an elaborate argument for a graded inheritance tax, which he believed would bring some relief to the poor and discontented, "has just passed through the most threatening political campaign in its history. The portents in 1896 were vastly more dangerous than those of 1860, when peace and internecine war hung in the balance. Issues were advanced last year, and vigorously supported by a large element of the American electorate, which, if adopted, would have undermined the very foundations of American institutions. These issues were largely the outgrowth of discontent among the people. The farmer, as a class, the work people, and the small trade folk were in distress. . . . Hundreds of thousands of industrious people were out of employment, the best efforts of the farmer had been attended with poor results, and the small tradesman and business man were worse off than if they had been doing nothing." In the report for the following year he spoke again of the "public discontent and dissatisfaction with existing conditions in this State." Instead of joining the comfortable and contented in a denunciation of them as a delusion, born of envy or criminal instincts, he expressed the opinion that they had a very substantial basis. "My four years of close official study of the State finances," he says, "compels me to say there is serious ground for complaint." After giving an impressive summary in another place of the enormous increase of public expenditures within recent years he is moved to ask, "Whither are we drifting?"

The answer commonly given to this question is one quite flattering to American vanity. It is that we are drifting away from "parochial" things and taking our proper place as a great "world power." Having solved all the petty problems that have absorbed our thoughts and energies for a hundred years, we have gone forth to "take up the white man's burden," and to solve the greater problems that a discriminating Providence has so wisely confided to our ability and philanthropy. At the same time we are going to have our say as to how the affairs of the world outside of our narrow and cramping borders shall be managed. Mr. Roberts,

however, does not appear to take any such pleasant view of the future. He has none of the blood of Don Quixote flowing in his veins. The bestowal of the blessings of a Christian civilization with machine guns upon breech-clouted savages has no attractions for him. He sees that we have made such a disgraceful failure of the management of the contemptible things in which we have been so ignobly absorbed that we are threatened with national decadence! "While the contests against unjust and oppressive taxation," he says in his report for 1899, "have been the contests of freedom and civil and religious liberty in the world, it must not be forgotten that unjust and burdensome taxation has been in all ages the most prolific cause of national decadence as well. There are nations in Europe, once great and prosperous," he adds, thus recalling the warnings of Lord Salisbury's famous speech on the same subject, "which to-day seem dying of dry rot because, to meet their immense expenses and to pay interest on their great bonded debts, taxation has been increased beyond the safe limit, and the very sources of national prosperity have been taxed so that they run dry, or send down a rill where it should be a river. Few national diseases are more dangerous or harder to cure than burdensome taxation. Can any one charged with the responsibility of making tax laws," he asks, profoundly stirred by the startling facts that have come under his observation, "afford to ignore the undoubted lessons of history or the manifest tendency of the times in the matter of revenue raising and expending?"

Obvious as is the fitting answer to this question, it is one that few people stop to give. Both the lessons of history and the tendency of the times are willfully and incessantly ignored. Not only are they ignored by demagogues, who thrive most when public distress is greatest, and by misguided philanthropists, who seek to relieve it in ways that only intensify it. Even publicists, whose studies in history ought to make them more familiar with the signs of social decadence than a man of affairs with vision less extended, ignore them also. They seem to be as insensible to the real significance of what is going on before their eyes as the wooden totems of a burning tepee. But to minds more alert and penetrating, even if less congested with musty lore and fine intentions, the flight of the farming population to the cities is something besides "a great natural movement toward urban life that accompanies an advance in civilization"—it is a desperate but futile attempt to escape conditions that have become too hard to be borne. The swarms of impoverished and degraded humanity that crowd the slums to suffocation are not altogether the product of willful sloth and incapacity; they are due, in a measure, to the growing taxation that has

wiped out the narrow margin that separates independence from dependence—self-support and self-respect from destitution and pauperism. The hatred of the rich, the denunciation of capital, the contempt for the Church, the bloody insurrections of labor, the general feeling of rancor, accompanied by an increase of the tyranny of trades unions and government regulations, are not the inevitable manifestations of envy, ignorance, and criminal instincts; they are the inevitable fruits of the perpetual aggressions in a thousand forms that spring from politics and war. But instead of acting upon this natural interpretation of the signs of the times and seeking to solve the social problem in the only way that it can be solved, the "new" reformers tormenting the world are engaged in the invention of schemes that add to the public burdens and hasten the nation's decay.

The reckless expenditure of public money in the United States has not been confined to any particular political division nor to any particular geographical section. The national, State, and municipal governments have seemed to vie with one another in the plunder of the taxpayer. From the North, the South, the East, and the West have come the same complaints of excessive burdens.* But figures are needed to give these statements the vividness of reality. Beginning with national expenditures, Mr. Roberts says that during the decade from 1820 to 1830 they were $1.07 per capita; from 1851 to 1861, they were $2.06; and for the year 1894, $6.08. "In a word," he adds, "the per capita expense of the national Government in 1894 was nearly six times as great as it was in 1820, and nearly three times as great as it was in the decade before our great civil war." The per capita expenditures of the State of New York in 1830 were $1.30, thirty years later

* From the mass of proofs of this statement in my possession I will select only one. In a call for a convention at Portland, Me., on the 10th of June last, of all persons "interested in the revision of the present system of State taxation and a more economical management of the State affairs," it is stated that "the expenses of the State have increased fifty per cent in ten years, while the wealth and population of the State have steadily declined." The object of the convention was "to protest against the course of extravagance that is rapidly bringing reproach upon the government of the State and reducing the farmers and taxpayers to automatons to grind out revenue to be absorbed by a rapacious and ever-multiplying horde of office-holders, who devour the people's substance as fast as they produce it." After showing how "once prosperous farming towns and townships have been reduced to but little better than a howling wilderness, the call says in conclusion: "These once prosperous farming communities were redeemed from the native wilderness by men who were no more temperate, industrious, or economical than the farmers of to-day, and the prices they received for their products were as low as, and in some instances lower than, to-day, but the fruits of their honest toil were not drawn from them as fast as acquired by national, State, county, and, in many instances, by municipal extravagance, as it is to-day." The plundered peasantry of Spain, Italy, or Russia, army ridden as they are, could not have made a more just complaint.

they were \$1.89, in 1890 they were \$2.15, and "in 1897 the estimated per capita expenditure reached the alarming amount of \$4.95." That is to say, the combined expenditures of the State and national governments gave a rate as high as that prevailing in France before the outbreak of the Revolution. "The tendency to increase," says Mr. Roberts, commenting on these figures, "is a persistent one. In 1881 the amount expended by the State was \$9,878,214.59; in 1884, \$10,479,517.31; in 1887, \$14,301,102.48; in 1890, \$13,076,881.86; in 1893, \$17,367,335.98; and in 1896, \$20,020,022.47." Coming to municipal expenditures, where the hand of the prodigal has been most lavish, Mr. Roberts says that "between 1860 and 1880 the municipal debts of our Union increased from \$100,000,000 to \$682,000,000, and in fifteen cities, believed to represent the average, the increase in taxation was 362.2 per cent, while the increase in taxable valuation was but 156.9 per cent, and of population but 70 per cent. In the year 1860 the direct taxes for State, county, town, and city purposes in New York were \$4.90 per capita, in 1880 it was \$8.20, and in 1896 it had reached \$10.43, an increase in thirty-six years of 213 per cent." It should be added that the bonded debt—State, county, city, town, village, and school district—in the State is estimated by Mr. Roberts to be \$450,000,000. Is it any wonder that people so mercilessly plundered feel that the times are out of joint? Is it any wonder, either, that in 1896 Mr. Roberts was moved to say that, without the discovery of new sources of revenue, "a low tax rate would never again be enjoyed in this State"? Is it any wonder, finally, that he declared again that if "we have not yet passed the danger limit of taxation," we have reached "a point where there is a deep feeling of unrest and dissatisfaction, and where a halt should be called or there will be danger"?

The stock explanation of this growth of expenditure is that with the advance of civilization the cost of government must increase in like degree; there must be more regulation and supervision of the activities becoming more numerous and complex. But this means, if it means anything, that the more enlightened and humane people are, the more difficult it is to maintain order and enforce justice, the more inclined are they to attack and plunder one another—in a word, the more barbarous they are. Preposterous as this theory of civilization is, it is precisely the one upon which the American people are acting with unparalleled energy. While we should naturally think them moving toward a point where they could get along without government, they are moving toward a point where they will have nothing but government. Referring to the increase of expenditures already mentioned, Mr. Roberts

says it "corresponds almost exactly with the increase of the number of commissions and departments. . . . These departments and commissions," he continues, "are largely for the purpose of extending social supervision and regulation over many things which, in the earlier days of our Commonwealth, were left to the localities or to self-regulation." Again he says: "The amount of State inspection has become very great, reaching out constantly over new fields, and employing in the aggregate an army of inspectors. . . . The system of *laissez faire,* which was the rallying cry of democracy and free government at the beginning of the century, has yielded gradually to a system of supervision and control which monarchies never attempted. . . . What our State has done in this line can not probably be undone," he says in a repetition of his warning, "but this tendency to expand and multiply and differentiate and segregate State supervision and regulation must cease, or the burden will soon become too grievous to be borne."

But there is no warrant for the assumption that the more civilized we are—that is, the greater our self-control—the more are we in need of inspection and regulation. Such an explanation of the enormous increase in public expenditure is worthless. The true explanation lies in the greed of politicians and the delusion of social reformers. To both of these causes must be attributed the evils that Mr. Roberts deplores. "The truth of history," he says, referring to the thirty-six new offices and commissions created since 1880, "compels the statement that it looks as if many of these creations were made not so much to satisfy a public want as to relieve a political situation." That is to say, they were designed to provide spoils for the insatiable maw of politicians. One of the most flagrant examples of this popular method of forwarding the beneficent work of civilization and hastening the dawn of the millennium is the State Board of Mediation and Arbitration, created in 1886. Up to the present year it has cost the taxpayers $195,828.57. For this expenditure little can be shown but a shelf full of reports seldom read, and a pigeon hole of vouchers for salaries never earned. With one of the former members of this board, who served thirteen years and received $39,000 for his able services, I am personally acquainted. Of my own knowledge, I can say that for nearly three years at least his duties as commissioner never interfered perceptibly with his duties as editor. That most of the other offices and commissions are equally worthless there can be no doubt. Altogether they have cost the State the startling sum of $31,768,899.85, and are increasing the public burdens at the rate of more than $1,000,000 a year. But their true character as asylums for decayed politicians, or as stepping stones for ambi-

tious young ones, and at all times as centers of political intrigue and personal profit, is gradually dawning upon the public. Already several Governors have demanded, in their annual messages to the Legislature, that they be consolidated or abolished. As yet, however, it has been impossible to relax their grip on the taxpayer. Obedient to the instincts of their kind, they are inventing new arguments to establish their claims to the confidence and gratitude of the victims of their greed and incompetency.

But the creation of new and needless offices is not the only manifestation of what Mr. Roberts fitly calls "the vicious tendencies of legislation." More demoralizing are the laws that actually encourage the robbery of one class of people for the benefit of another. A familiar example is the bounty law for the destruction of fishing nets. Almost as soon as passed it produced a new industry—namely, the manufacture of cheap nets, which were deposited in fishing waters, subsequently discovered and seized by a prearrangement, and made the basis of demands upon the public treasury out of proportion to their value. So great have been the frauds perpetrated under it that the cry for its repeal comes from every quarter. Another law even worse morally was passed to meet the clamor of the bicyclists and bicycle manufacturers. It provides that twenty-five per cent of the cost of so-called good roads to be built under it shall be paid by the State. As cities and villages are exempt from its provisions, this sum, which comes out of the pockets of all taxpayers, urban as well as rural, is, as Mr. Roberts says, simply "a gratuity to the towns for the benefit of country roads." As a sign of the moral decadence of the times, I ought to add that one of the most powerful and effective arguments in favor of the law was this very discrimination. Still more shameless was one of the chief arguments in favor of the Raines liquor law. With a moral callousness truly astounding, its advocates framed tables of figures to show how great a percentage of taxation it would shift from the country to the city districts. In the heated political campaign that followed, these tables were made to do service again to save from defeat the party responsible for the enactment. To indicate, finally, how legislation may encourage vice, I must not omit to mention the provision that created the Raines hotel. Under it assignation houses have multiplied to a degree that Satan himself could not have foreseen nor have been more enchanted with.

But the greatest inroads on the pockets of the taxpayer have been made under the pretense of charity. I say "pretense" because it is a gross misuse of language to decorate with so fine a word the seizure of a man's property under the forms of law and

to devote it to the ostensible relief of want and suffering. It is the infliction of an aggression that has no more warrant in a court of sound morals than the seizure of his property in disregard of the forms of law. Yet this evil has reached such vast proportions that Mr. Roberts was moved to protest against it. After speaking of "the tendency of the State in building up a gigantic system" that "will call for an enormous and ever-increasing annual expenditure for maintenance," he expressed the belief in 1896 that "the time has come to call a halt before this burden of taxation becomes too heavy." He then mentioned the significant fact that while the State spent $6,000,000 for charity, $4,800,000 for public schools, $800,000 for the militia, it spent only $500,000 for judges' salaries! He pointed out also that the expenditures under the head of charity had increased from $1,468,471.58 in 1887 to $5,888,193.74 in 1897, or over four hundred per cent in ten years. He added the prophecy that it would be "a matter of a short time only when the annual expenditures for charity alone in this State will reach $10,000,000." At that time five large State charitable institutions were in process of construction, and were soon to be thrown open to the public. In the following year he reverted to the subject in still stronger terms. "God forbid," he says, "that I should put a straw in the way of charity rationally directed; but my four years' experience as comptroller . . . compels me to say that charity is dispensed in this State with an almost lavish hand, and in my judgment it is in many cases unwisely dispensed." In his last report to the Legislature the aggregate cost of the fourteen great institutions in operation, with a population of 6,621, is put at $6,898,304.52.

That this enormous largess, wrested from the taxpayers without the slightest consideration for their own wants and sufferings, is unwisely dispensed in many cases Mr. Roberts furnishes the amplest proof. The charges that he brings against this form of State activity are most serious. They reveal the same odious traits that characterize the management of public affairs in no wise connected with the love of humanity. "Nearly every locality," says Mr. Roberts, "having a State charitable institution deals with it as though it were established to afford that locality an avenue through which to reach the State treasury, and in most cases, where a majority of the managers live under or are dominated by local influence, the avenue has been profitably traveled. The result of such predominance is combination among local dealers, a division of the furnishing of the supplies among them at greatly advanced prices, the palming off upon the institution of inferior articles which would find no sale in the market, a row with

the superintendent if he undertakes to expend money outside of the locality, and, through friction and disturbance, the work of the institution is more or less demoralized." He charges that "the only aim" of some institutions "seems to be the expenditure of their entire appropriation, irrespective of the number of inmates provided for or the results obtained." Putting the same charge in another way, he says that "the cost of an institution is more frequently based upon the amount of the appropriation granted by the Legislature than upon its real or apparent necessities." When it is remembered that the managers of the institutions against whom these astonishing charges are brought are picked people, representing much more than the average character and ability, the conclusion is not unnatural that ward heelers and caucus packers have no monopoly of the rotten ethics of politics.

If we look a little further into the management of the institutions, all the familiar footprints of the unscrupulous politician become visible. Money appropriated for specific purposes is diverted from them. Over fifty-five per cent of the amount expended in 1898 under special appropriations was used for the benefit of two institutions, leaving less than forty-five per cent for the remaining fourteen. Plans for new buildings or the improvement of old are so changed as to require an expenditure considerably in excess of the money appropriated for the purpose. Not infrequently the excess ranges from twenty-five to fifty per cent, and thus the way is paved for further appeals to the Legislature to meet the dishonest deficits. A more reprehensible use of public money is appropriations for new buildings and improvements of old ones belonging to private institutions. As examples, Mr. Roberts cites the expenditure of $77,473 upon the private property of the Malone Institute for Deaf-Mutes, and $457,556 upon that of the Randall's Island Reformatory. "In my judgment," he says, expressing an opinion that every fair-minded person will approve, "this is a mistaken public policy. If these institutions are to be steady recipients of State aid for permanent improvements, the title of the property should be transferred to the State." Otherwise any philanthropist might found a charitable institution to provide himself with congenial employment, and, availing himself of the courtesy of the State to thrust his hands into the pockets of his neighbors, make additions to it and keep it in repair.

But these are by no means the only ways that money picked from the pockets of taxpayers is poured into the bottomless pit of State philanthropy. One of the most common and most expensive is the unjustifiable increase of salaries. In 1894 and 1895, when the country was still in the throes of the great panic of 1893 and

when hundreds of thousands of people were glad to get work at almost any pay, the salary list of nine charitable institutions was increased forty thousand dollars a year. Indefensible variations in the per capita cost of practically the same service discloses another mode of waste. Mr. Roberts gives elaborate tables in exposure of this evil. While the per capita cost of the inmates of the Western House of Refuge for Women at Albion is $254.27, that of the inmates of the House of Refuge for Women at Hudson is $217.63. Again, while the per capita cost of the inmates of the State Industrial School at Rochester is $219.49, that of the inmates of the Reformatory on Randall's Island is $210.59. Still again, while the per capita cost of the inmates of the State School for the Blind at Batavia is $313.74, that of the inmates of the Northern New York Institute for Deaf-Mutes at Malone is $258.36. If it be remembered that the institutions on Randall's Island and at Malone are under private management, the lower rate prevailing there, compared with the higher rate at the Batavia and Rochester institutions, suggest a fact of no slight significance. "Private institutions," says Mr. Roberts, calling attention to it, "are only paid in some instances $110 per annum for the care and support of inmates, . . . while the cost in State institutions is more than $200 per annum." Yet, despite the possible indefinite multiplication of such facts, the "new" reformer pins his faith to the State as a fit agent for the regeneration of his fellows.

Before leaving these institutions I must call attention to another characteristic form of waste. I refer to the delicacies furnished to the officials and inmates. "It has not seemed exactly right," says Mr. Roberts, setting forth the scandal in very moderate terms, "that the taxpayers of the State should be required to pay for Blue Points, lobster, terrapin, frogs' legs, partridge, quail, venison, and most of the delicacies of the season to supply the tables of officials already well paid and well housed by the State." But solicitude about table economies was never known to be a trait of bureaucratic parasites. They never trouble themselves to prolong their vision to the meager tables of the poor and suffering robbed of the necessaries of life to load theirs with luxuries. The same limited vision is exhibited on holidays in their generosity at other people's expense. "Is it fair," says Mr. Roberts, protesting against this touching display of human goodness, "that the average workingman should wear poor clothes and live on plain fare in order that he may bring up his family decently and honestly, while the inmates of State institutions are indulged with turkey at eighteen cents a pound, footballs at $4.83 each, oranges, candy, nuts, ice cream, and expensive luxuries? . . . It

must not be forgotten," he adds, mentioning a truth commonly forgotten even by people that have reached a higher civilization than that of the average State official, "that the money spent for these inmates is not voluntary contribution, but is the product of enforced taxation." *

Resistance to aggression is one of the fundamental instincts of the human race. It has been enforced during countless ages by

* But I ought to add that this mismanagement of State charitable institutions is duplicated in the management of other State departments that came under Mr. Roberts's observation. Although more than $24,000,000 have been spent on the new Capitol, it proves to be too small for the purposes it was designed to meet. Mr. Roberts recommends the conversion of the old State Hall into a finance building. The State Library has become so large that it will soon require a separate building. The racing tax law was so bunglingly framed that the collections under it in 1896 were attended with "more difficulty and expense than usual." As the forest-preserve law stood in 1896, it permitted people purchasing State lands to strip them of lumber, and then, owing to certain irregularities connected with the sale, making it illegal, to recover the money originally paid with interest at six and seven per cent added. Because of the absence of any law covering the personal expenditures of members of legislative investigating committees, claims for seven and eight dollars a day are rendered, although four or five dollars a day are believed to be ample. Let me add that these investigations, which, during the period from 1879 to 1896 inclusive, cost $823,534.51, reveal another source of waste from State management. Still another source of waste is State printing. Pointing out the "growing expenses of State printing," Mr. Roberts shows that they have increased from $95,029.51 in 1887 to $315,585.81 in 1896. At one time the law was so defective that it was impossible to frame specifications for bids that would allow for printing of different kinds. For example, blanks varying from two to three inches square to two and three feet had to be classed in the same schedule and price. A needless quantity of reports is printed. Some of them are printed in the highest style of the art and richly embellished with expensive plates and engravings. One report for 1895 cost $42,000, and others cost as high as $20,000 and $30,000. "It does not seem logical," says Mr. Roberts, commenting on this extravagance, "to spend as much on the illustration of a report as it costs for clerk hire in many departments." Another evil is the failure of the Legislature to appropriate money enough to meet the printing bills each year, thus making it necessary either to borrow money to pay them or to compel the printer to wait for his pay at a loss of interest on the amount due him. In this connection attention must be called to the failure of the Legislature to provide money enough to cover expenditures during the period intervening before funds are available from taxation. Although Mr. Roberts recommended repeatedly legislation for the avoidance of this difficulty, which causes waste, no attention was paid to him. The management of court and trust funds by county treasurers has been particularly scandalous. In disregard of the express direction of the courts, thousands of dollars were retained by parties or their attorneys for their own personal benefit. Money has been paid out by county treasurers without certified orders of the courts merely upon the assurance of attorneys that the payments were proper. The rules framed by the comptroller in regard to this matter were constantly disregarded. Excessive allowances were made for costs of attorneys. In the case of one estate of $750, thus robbed, only $60 remained for the payment of the debts against it. By the defalcations of county treasurers, court and trust funds are often depleted, and the beneficiaries, often widows, orphans, and unfortunate litigants, are robbed. Mr. Roberts has recommended legislation on this subject, but no attention, as far as I know, has been paid to it. It is one of those "parochial" questions that the American people appear to have no taste for. But it would seem as if the protection of citizens, especially the poor and weak, was the first duty of the State.

the penalty of extermination. Only the people that refuse to be killed, or robbed and enslaved, which are modified forms of the same crime, can respond to a scriptural injunction; they alone can be fruitful, multiply, and replenish the earth. All others must succumb to the pitiless law of the survival of the fittest. Efforts to escape taxation not sanctioned by justice, so common throughout the United States, are not, therefore, exhibitions of hopeless depravity; they are exhibitions of the natural desire for self-preservation that demands study and heed.

In New York State the efforts of taxpayers to escape this increasing aggression have had a deplorable effect. To still the voice of discontent and complaint, legislators have tried to lay on their burdens as lightly as possible. Acting upon a familiar definition of taxation, they have tried to pluck the goose so as to get the most feathers with the least squawk. But in their observance of the principles of humanity they have shown but slight regard for the principles of economics or justice. Mr. Roberts characterizes their enactments as "confused, illogical, and conflicting"; he adds that they are "nearly all legislative makeshifts, and many of them blunders." The moral effect of the aggression has, however, been more disastrous than either the economic or statutory. To escape it, the owners of every class of property, no matter what their intelligence, their religious professions, or their social standing, resort to every possible subterfuge. With the cries of the tortured fowl ringing in sympathetic ears, complaisant officials refuse to assess real estate, as required by law, at its full value. "The assessor," says Mr. Roberts, describing this form of evasion and its evil consequences, "undertakes, by reducing valuations on his own responsibility and in defiance of law, to protect his own county or town from paying more than its fair proportion of tax, and self-interest lulls the moral sense of the community into support of his action." The same law of assessment applies to the whole State, yet there are twenty-five rates of assessment in the sixty counties, and these rates range from fifty to ninety-two per cent of the value of the land. The owners of personal property avoid their obligations in a manner still more reprehensible. They either conceal it or lie about it. While its amount during the past forty years has reached the enormous total of $18,000,000,000, or more than four times the value of the real estate, its assessed value has not increased. It is Mr. Roberts's conviction, based upon "study and observation," that not "more than three per cent" of it is assessed. The result is that, although real estate pays a revenue of over $9,000,000 a year, personal property pays one of only about $1,000,000. As to the corporations, they are equally alert in

avoiding their obligations. Before the enactment of a recent law they did it by watering their stocks and issuing bonds, thus creating an indebtedness equal to their capital. They do it now by incorporating in other States and carrying on business in this State. They do it also by neglecting for a certain time to make the reports required by law, and then taking refuge behind the statute of limitations. If the burdens thrust upon them can not be shirked or borne, they fly to other States, where the aggressions of the tax collector are less ruinous.

To compel officials to do their duty, countless expedients have been invented from time immemorial. In the face of proof mountains high that no legislative or administrative device can uproot the selfishness imbedded in human nature or reshape the conduct molded to this immutable fact, social quacks still continue to spawn their schemes to work the miracle. Slight as is Mr. Roberts's sympathy with them, he is no exception. As a panacea for the dishonesty and incompetency of the county treasurers that mismanage court and trust funds, he recommends the substitution of State for local inspection. By a similar application of hocus-pocus, he would transmute the extravagance of the managers of charitable institutions into exemplary economy. Disgusted with the charlatans in charge of certain duties connected with these institutions requiring special skill and knowledge, he thinks "it would be well to provide a corps of enthusiastic scientists . . . who have more than a pecuniary interest" in their work. But another recommendation of his is a direct assault on this simple faith in the honor and integrity of specialists. Already many of the departments of the State are in the hands of men supposed to have a special aptitude and liking for their duties. But Mr. Roberts finds that "leaving the department to expend the money as it deems best," instead of appropriating it for a specific purpose, "is not in the interest of economy." He says that "it absolutely deprives the Legislature of that judicial scrutiny of the necessity of appropriations" that "it should always exercise, and leaves to the judgment of one what could often be better decided if considered by several." Could a deadlier blow be given to a common theory that under government management we have the same division of labor and the same perfect adjustment of means to ends that we have under private management? What legislative body, chosen by universal suffrage, the most perfect instrument ever invented for the selection of incompetents, would enable it to exercise the supervision over the thousand activities of life that Mr. Roberts recommends?

The same futile ingenuity exhibited in making officials do their

duty is exhibited in making taxpayers do theirs. One of the multitude of plans suggested is a single tax on land; but that does not seem promising, for it would not prevent the discriminations that assessors make—discriminations that Mr. Roberts himself believes to be beyond the reach of even State supervision. Another is a more rigid enforcement of the personal-property tax; but this is equally unpromising. "The fact is," says Mr. Roberts, "that from the dawn of civilization the wit of man has failed to discover a plan by which intangible personal property could be made to pay its share of taxation, and it will never be made to pay on the ordinary assessment plan." Besides the increase of taxes on corporations, the taxation of franchises, which has just been authorized, and a general revision and simplification of tax laws, it has been proposed that a graded inheritance tax be adopted. Mr. Roberts is particularly enamored of this idea. But his advocacy of it betrays the same disregard of the rights of others, and leads to the same appeals to specious facts and arguments that always accompany the commission of aggression in politics as well as in war. His reasoning is that since "special privileges conferred by government," such as tariff laws, corporation laws, public franchises, etc., are "the foundation of most of the great fortunes of the country to-day"; since these fortunes are, to a considerable extent, "composed of personal property" that "very largely escapes taxation"; since the decedent has been "allowed the use and enjoyment of his fortune during life," and the beneficiary simply pays "a fee for the privilege of receiving an estate in the creation of which he had little or no hand"; and, finally, since he can make no just complaint against the payment of such a fee, as his right to receive his fortune "comes from the State—is by the grace of the State"—the seizure at death of a certain percentage of all estates beyond a prescribed amount would be only justice to "the mass of small landowners and taxpayers who have from year to year borne more than their equitable share of the burden of taxation." But the fallacies of such an argument are easily exposed. The moral ownership of property does not lie in the State; it lies in the labor and skill of the man that accumulated the property. The moral title to a bequest does not lie in that fiction either; it lies in the right of the decedent to do whatever he pleases with his own. If great fortunes have been unjustly acquired in consequence of special privileges a great wrong has been committed, and it is not righted by the commission of another wrong. The only reparation that can be made is to abolish the privileges. So obvious a suggestion does not, however, appear to have occurred to Mr. Roberts.

But even if all the reforms in taxation that could be imagined were put in operation they would not meet the situation; they would not deliver the American people from the great and alarming evil of over-legislation and excessive taxation. An increase of revenue, like an increase of supervision, is almost certain to increase the injustice that it was designed to abate. The first year's operation of the Raines law contributed more than $3,500,000 to the State treasury, yet the addition to the public expenditures that accompanied its enactment made a high tax rate necessary. What the situation requires, therefore, is not more but less social regulation and taxation. We need also a gradual restriction of the duties of the State to the limits laid down by Mr. Spencer—to the preservation of order and the enforcement of justice. Although not apparently a disciple of that philosopher, Mr. Roberts himself virtually subscribes to this view. In his last report he demands "far greater economy and care in public expenditures, and no further excursions in the field of social supervision and regulation."

LATEST DEVELOPMENTS WITH THE X RAYS.

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WE have become accustomed to seeing photographs of the bones of our hands, and we no longer stop at shop windows to look at X-ray photographs. Indeed, they are rarely displayed, and the lecturer who once gazed on a sea of faces as he endeavored to explain the most marvelous electrical sensation of this century now addresses a mere handful of listeners. Such patient hearers continuing to the end may still hear of marvelous performances of this strange light of which the great public are even now ignorant, and in this paper I shall take my readers into a physical laboratory and endeavor to make the generally unknown manifestation of the new rays plain and free from technical language. I am sure that we shall all leave the laboratory with our imagination full of thoughts of unknown movements in the air about us—thoughts of possible telepathic waves through space, conceptions of new ranges of nerve excitations, hopes of new lights, conceptions of the vastness of the electrical whirls in that elevated region where the molecules of the air, in their endeavor to fly into the abyss of space, are controlled by the earth's forces and are endowed with electrical energy by the sun.

In the first place, what is the present state of our knowledge of the X rays? Have we more efficient methods of producing

them, and can we see farther into the recesses of the human body? In regard to the first question, we can say that, although we may not be able to answer dogmatically that we know what these rays are, we have valuable hints in regard to their character, and our knowledge of their manifestations and their relation to light waves and magnetic waves has greatly increased during the four years which have elapsed since their discovery. They are now believed by the best authorities to be magnetic and electrical pulses, or waves of extremely short length. In the spectrum of sunlight formed by sending a beam through a prism of quartz the X-ray pulses or waves are to be found, according to this hypothesis, beyond the violet color of this spectrum—far into the dark region invisible to the eye, and only brought into view at present by the aid of photography. In this invisible region reside many singular manifestations of energy closely analogous to those of the X rays. The ultra-violet rays invisible to the eye have the property of refraction. They can be bent out of their course by prisms made of quartz. The X rays, however, can not be directed from a straight course. This is their greatest peculiarity, and many attempts, both mathematical and experimental, have been made to elucidate it. It is not a fatal objection to the X rays being classed with light waves, for, under certain conditions, even light waves can be made to lose the power of being bent aside.

Leaving for the present a further discussion of the question What are the X rays? let us examine what the actual condition of the art of using the rays is. Many attempts have been made to improve the Crooke's tube, in which the rays are produced, but, like the hand telephone, its form has remained substantially unaltered since the first flush of discovery. Its present form consists of a bulb of thin glass, exhausted of air, containing a little concave mirror of aluminum, and opposite to this, separated by a gap of several inches, is an inclined sheet of thin platinum, called the focus plane, or anticathode. The electrical discharge passes between this plane and the mirror, and the X rays are thrown off from the inclined sheet of platinum. They are not reflected in the ordinary sense of the term, but the electric rays converge from the mirror to a spot on the platinum which glows with a red heat, and the X rays emanate from the heated spot as if it were their source. Thousands of investigators have endeavored to improve the form of tube, but, with several important minor appendages, it still maintains the principal features of an aluminum concave mirror and an inclined plane of platinum. Aluminum is found to be the best metal for the mirror from which the rays are generated, largely because its metallic particles are not torn off by the discharge, as

would be the case if it were made of platinum. It is also light, and can be easily fixed to a platinum wire. Among the important modifications of the tube are those which enable the operator to control the degree of vacuum in the tube. This is accomplished by sealing to the main tube an appendage containing certain chemicals which, on being heated, give off a small amount of vapor, and which take it up again on cooling. This modification is made necessary by the singular fact that after a Crooke's tube is submitted to an electrical discharge for some time the vacuum becomes more and more complete, and a higher and higher electro-motive force or pressure is needed to produce the discharge in the tube. It prefers in time to jump over the surface. Thus, at the very beginning of our use of the X rays we meet with a mystery. Where do

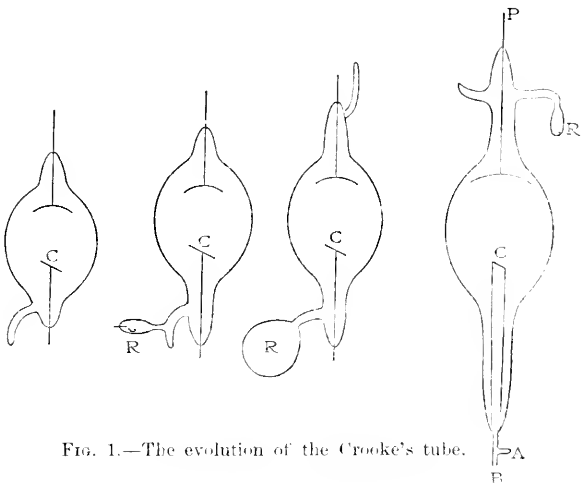

FIG. 1.—The evolution of the Crooke's tube.

the remaining particles of air go? It is surmised that they disappear in the platinum terminals.

The manufacture of the X-ray tubes tests technical skill and the patience of the experimenter more highly, perhaps, than the preparation of any apparatus used in science. Glass working is a difficult art, and requires an absolute devotion to it. There is only one metal known which will enable an electrical discharge to pass into and out of a rarefied space inclosed by glass. This is platinum. A wire of this metal can be sealed into glass so that no air can leak into an exhausted space around the joints. All electric lamps, so commonly used in electric lighting, have little wires of platinum at their bases, by means of which the electric current enters and leaves the bulb. The Crooke's tube is in principle an Edison lamp with the filament broken. The maker of Crooke's tubes should complete the making of the tube at one sitting, for

reheating of the tube is very apt to lead to a disastrous cracking of the glass. He must take the utmost precautions against unequal heating and sudden cooling, and he must, above all, have phenomenal patience.

Fig. 1 shows the evolution of the Crooke's tube which is used to produce the X rays. The first form of tube was barely larger than a goose's egg. The size has been gradually increased, and at present it is three or four times larger than the original form. The interior arrangement has not been materially changed, and consists, as we have said, of a concave mirror, which constitutes the negative electrode, and an inclined sheet of platinum, from which the X rays seem to emanate.

The later forms of tube have accessory chambers, filled with certain chemicals, which, on being slightly heated, reduce the vacuum to the desired point. Certain forms of tubes have merely an additional chamber which, on being heated, reduces the vacuum in the main vessel. The latest form of tube, devised by Dr. William Rollins, of Boston, has a hollow anode tube (*B C*, Fig. 1), through which a current of water can circulate in order to save the tube from breaking. The end of this anode tube is small, in order to form a sharp radiant point of light. One of the platinum wires (*P*) inserted in the tube projects outside some distance. When the vacuum becomes too high in the tube, this platinum wire is slightly heated in a gas flame; then the flame is blown out and the hydrogen is allowed to flow against the heated wire. A sufficient amount of the gas is absorbed by the heated wire to reduce the vacuum in the tube. This tube stands very powerful electrical discharges, and is the most scientifically designed tube at the command of the experimenter.

There are three methods of generating the electrical discharge which produces the rays. The commonest method is that in which the Ruhmkorf coil is used. This coil is what is now known as a transformer, and consists of one coil of a few turns of coarse wire, which is connected to a battery or other source of electricity, and of another coil surrounding the first of a great number of turns of fine wire. Any sudden change of the battery current produces an electric pressure or electro-motive force at the ends of the fine coil of wire. By this simple arrangement of two coils we can thus exalt a current of low pressure to one of high electro-motive force. A battery current which can barely produce an electric spark of one hundredth of an inch at the ends of the coarse coil can cause a spark of eight inches or more at the terminals of a fine coil.

In the second method one uses an ordinary electrical machine in which the glass plates are supplanted by rubber ones, which are

run at a high rate of speed. Both of these methods have their advocates. The use of the Ruhmkorf coil is the most universal.

The third method consists in charging a number of Leyden jars by a storage battery and in discharging these one after another, so as to obtain a high electro-motive force. This method is a very flexible one. I can experiment with my apparatus over a range of electric pressure extending from twenty thousand units to three million. The electrical discharge produced by three million units or volts is over six feet in length.

The apparatus for discharging the Leyden jars or condensers in series is represented in Fig. 2.

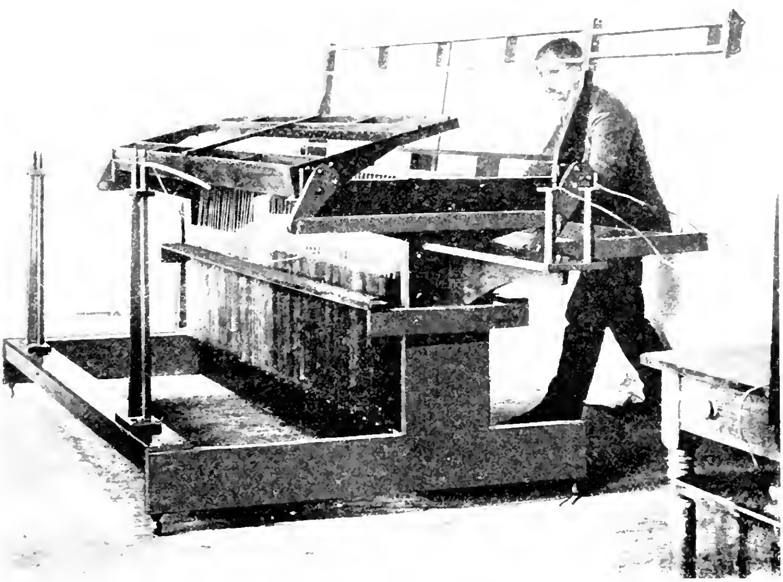

FIG. 2.—Apparatus for producing electrical sparks six feet in length.

A fourth method, first used by Professors Norton and Goodwin, of the Massachusetts Institute of Technology, consists in discharging a quantity of electricity through the coarse coil of a Ruhmkorf coil. This method obviates the necessity of a mechanical break to interrupt the battery current which is employed to excite the current in the coarse coil of this apparatus.

I have experimented with more powerful quantities of electricity than have been hitherto used. The accompanying photograph gives an idea of the magnitude of the quantity which I can use to excite the X rays.

It represents the discharge, burning a fine iron wire, and it

makes a noise resembling the crack of a pistol. Now, this discharge can be used in a variety of ways to excite various transformers in order to produce the best conditions for exciting the X rays. The method of using this powerful discharge to excite a transformer seems at present the most promising one in seeking the best conditions for obtaining rays of high penetrating power.

There is still another method of obtaining the rays yet in its infancy—the simplest method of all, for no apparatus is required.

It has been discovered that certain substances, like the salts of uranium, have the power of emitting rays which have all the properties of the X rays. The list of such substances is constantly increasing, and they are called radio-active substances. It is possible to take a shadow picture of the hand through a board by placing the hand on a covered sensitive plate, resting the board on the back of the hand, and strewing the board with one of these radio-active substances in the form of a powder. Can it be that all the skill and industry which has been employed to perfect X-ray apparatus is to be supplanted by a powder? The peculiar property shown by the radio-active substances leads investigators to surmise that we have evidence of new substances, and we have the waves radium and polonium.

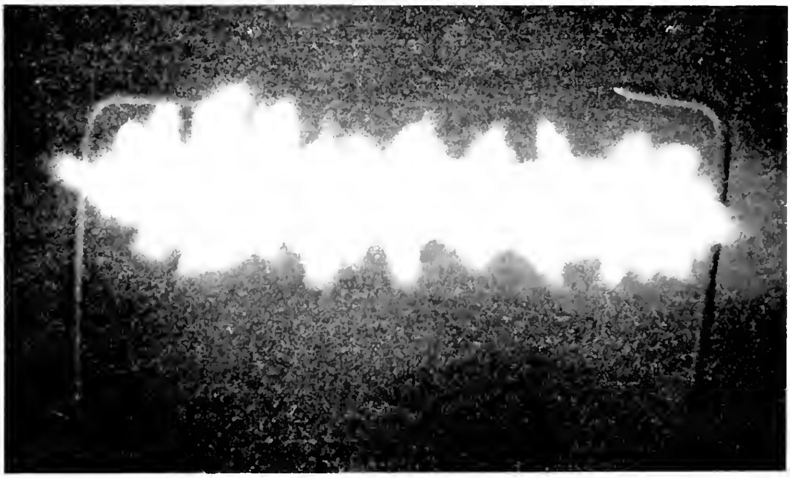

Fig. 3.—The burning of an iron wire by the most powerful electric discharge yet produced.

The methods by which the X rays are detected in practical employment in surgery have not been essentially changed. The ordinary photographic plate, shielded in a plate holder, is still used to receive the shadow cast by the bones, and salts of barium or of calcium strewn on pasteboard serve as fluorescent screens to receive

on their luminous surfaces these shadows and to make them evident to the eye. An interesting use of flexible sensitive films instead of glass plates has been made in dentistry. The films are put in the mouth, and the Crooke's tube placed outside in such a position that the rays can pass through the jaw. In this way the accompanying photographs were taken (Fig. 4).*

The use of photographic films in the application of the X rays in surgery will doubtless extend; we can easily imagine cases

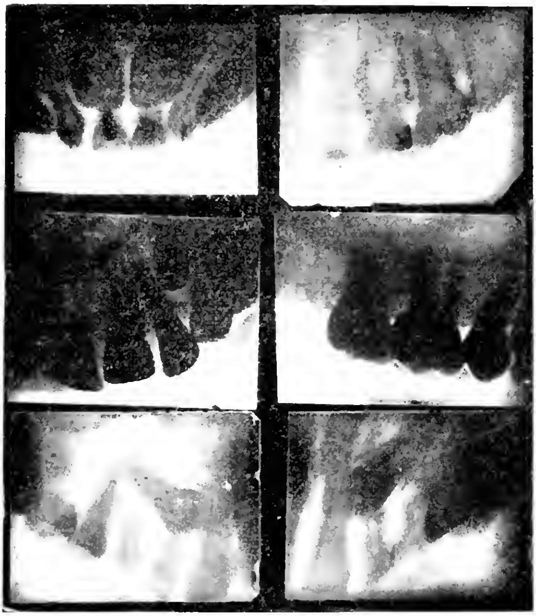

Fig. 4.—1. Male patient, aged ten years. Temporary incisors in position with the permanent incisors nearly ready to erupt. The roots of the temporary teeth nearly absorbed. Right temporary central cut incisor destroyed by a blow five years previous, showing gutta-percha filling put in at the time which, with the dead root, has been absorbed (same as the live root of the other central). It is taught in the text-books that teeth with dead nerves are not absorbed. 2. Temporary molars in position with no signs of the permanent bicuspid which should take its place. 3. Patient, aged ten years. Shows the open ends of the incisor roots. 4. Shows one bicuspid and two molar teeth. The roots of the teeth pass through the floor of and into the cavity of the antrum. The spongy character of the bone is shown. 5 and 6. Superior jaw, right and left sides, showing temporary cuspid teeth in place, with the permanent cuspids imbedded in the jaw entirely covered.

where the necessity of the use of the knife may be avoided by the information which a carefully placed film might afford. In general, X-ray photographs convey more information to the skilled eye of the specialist than to the untrained inspector of them. They should be studied from the negatives themselves, for the delicate details can not be reproduced in a print. It is remarkable that shadow pictures can show so much definition. Here is a photo-

* Kindness of Dr. Dwight M. Clapp, Boston.

graph of an elbow joint which shows the texture of the bones (Fig. 5).*

The use of the fluorescent screen, too, has been greatly extended. Dr. Francis H. Williams, of Boston, has used it as a valuable instrument in medical diagnosis, especially in studying lung diseases. It has been used at the Harvard Medical School to follow the processes of digestion. To accomplish this, in one instance a goose was fed with food mixed with subnitrate of bismuth, a salt which absorbs X rays.

The passage of the dark mass down the long neck of the bird could be traced on the fluorescent screen, and the peculiarities of its motion in the gullet could be studied. A cat was also fed with

Fig. 5.—Photograph of an elbow joint, showing the texture of the bones.

the same substance, and the movements of its stomach noted. These movements were analogous to those of the heart—in other words, were rhythmical when the processes of digestion were going on normally and uninterruptedly. When, however, the cat was irritated, it may be by the sight of a dog, these pulsations instantly ceased. As soon as the source of vexation was removed and the purring of the animal showed a contented frame of mind, the stomach resumed its rhythmical movements. The dependence of the digestive apparatus on the state of the nervous system was thus clearly shown. The female cat was much more tractable under these experiments than the male.

The use of the X rays is accompanied with some danger if the Crooke's tube is not properly used. A long exposure to the X rays is apt to produce bad burns which are like sunburns, and lead in certain cases to bad ulcerations. They are long in healing and are characterized by a peculiar red glow, especially on exposure to a cold wind. To prevent them one should place a sheet of thin aluminum between the Crooke's tube and the part of the body

* Taken by Professor Goodspeed, University of Pennsylvania.

submitted to the rays. This sheet should be connected to the earth. This fact should be borne in mind when we come to speak of the electrical region outside a Crooke's tube.

Many investigators, reflecting upon the singular fact that the rays pass so freely through thin aluminum and that, on the contrary, glass absorbs such a large percentage, concluded that Crooke's tubes provided with aluminum windows would be an improvement upon the thin incandescent lamplike bulbs now used. The glass of these bulbs is very thin, not more than one thousandth of an inch in thickness, where the rays emerge, not thicker than a sheet of ordinary note paper, and the absorption of such a sheet of glass is so small that it can not be detected by photography. Thus a sliver of glass of this thickness in the hand would not appear on the X-ray photograph of this member, and would not cast a shadow in the fluoroscope. There does not seem, therefore, any advantage in supplying a Crooke's tube with an aluminum window. The mechanical difficulties, too, in accomplishing this are very great. There is no way of joining the thin aluminum disk to the glass so that an air-tight joint can be made. In the process of exhausting the Crooke's tube, the tube must be heated to a comparatively high temperature in order to drive off the air which clings to the inside of the glass. The rise of temperature would soften or melt any current which might be used to make the aluminum adhere to the glass.

We can not expect, therefore, any improvement in the direction of aluminum windows. At one time, I suppose that the rays were highly absorbed in passing through atmospheric air, and that it would be an improvement in the application of the rays to surgery to interpose, so to speak, a vacuum chamber between the body and the source of the X rays. The experiment led to some interesting results, but not in the direction anticipated.

The vacuum chamber consisted of a glass cylinder three feet long and about eight inches in diameter. The two ends were closed by sheets of aluminum, and it could be exhausted through a side tube. The reader will immediately ask, in view of what has been said, How could the glass tube be hermetically closed with sheets of aluminum? This was indeed a difficult matter, but less difficult than in the case of the Crooke's tube, for the ends of the glass cylinder were provided with heavy brass flanges, which were perfectly flat, and the sheets of aluminum lying smoothly could be confined by many bolts between the flange and suitable brass heads. This cylinder, having been exhausted, was placed between the Crooke's tube and the arm, for instance, in the hope that a greater depth of human flesh and tissue might be penetrated

by the rays. It was speedily seen that the absorption of the layer of air three feet thick could not be detected either by photographs or the fluorescent screen. The glass cylinder was then filled with rarefied hydrogen, but no advantage was apparent. If the photographs of the human hand were taken, one through the rarefied cylinder and the other through an equivalent thickness of air, no difference in clearness or depth of definition could be perceived. The amount of absorption by a column of air three feet in length is less than ten per cent. This result interested me greatly, for it shows the remarkable difference between the X rays and the cathode rays, which had been investigated by Crooke, Hittorf, and Lenard: for the cathode rays are greatly absorbed by atmospheric air, being reduced in passing through five or six inches of air to one four-hundredth part of their value.

The small amount of absorption of the X rays lifts them into the realm of very short wave lengths of light, for their behavior in regard to the absorption by air is very analogous to that of ultra-violet rays. Although the vacuum chamber, by which I looked, showed no absorption of the X rays, it disclosed a beautiful phenomenon. In a dark room this large tube, three feet long and eight inches wide, was filled with a roseate light, which wavered like the northern lights when the Crooke's tube was emitting the X rays. If the finger was brought near the glass walls of the cylinder a stream of light apparently emanated from a point on the inside wall of the cylinder. The hand thus had ghostly streamers giving an image of it, although the hand itself was invisible. These banners of light could be diverted in any direction by the hand or by any conducting body brought near, and gave a vivid conception of how the streaming of the aurora can be brought about by this flitting of conducting clouds or the drifting of moisture-laden strata of air below the rarefied space in which the beams of the northern light dart back and forth. Both in the case of the Crooke's tube and the aurora these streamers are produced by electrical discharges through rarefied air. The experiments show that outside the Crooke's tube there is a strong electrical attraction and repulsion, which is only revealed in darkness and in a cold, lifeless, airless space, such as exists between us and the sun. Can we not extend our thoughts from the contemplation of this laboratory experiment to that of the immensely greater play of electrical forces between the earth and the sun across the immense vacant space ninety millions of miles in distance?

The mysterious effects of the X rays on the molecules in the air form a great subject of inquiry, and the investigation of it promises to extend our knowledge of electricity and light and heat.

When the Crooke's tube is excited we are conscious of a mysterious activity within it, for its glass walls glow with a phosphorescent light, and if certain crystals, like the diamond or the ruby, are placed in the tube, this phosphorescent light is vivid. Outside the tube, in free air, these luminescent effects are also present. The air is under an electrical strain, which is shown by the auroral streamers when this air is rarefied, and an electrical charge can not be maintained on a pith ball—it is dissipated in some strange manner. Still stranger, an electrical current is greatly aided by the X rays in its endeavor to pass through air—they make for the time being air a conductor. Furthermore, these rays separate the air into positively laden and negatively laden particles.

The electrical discharge in the Crooke's tube is many-sided in its manifestations. Its energy seems all-pervading in the room where it occurs. Before the discharge passes through the rarefied space in the tube its energy manifests itself by a crackling spark, a miniature lightning discharge. This spark, five or six inches in length, can send out magnetic waves which extend far beyond the narrow limits of the room. They can be detected, by the methods of wireless telegraphy, fifty miles. When the same amount of energy is developed in a Crooke's tube the magnetic waves hardly pass beyond the walls of the room, and the phenomenon of phosphorescence and fluorescence and the strange molecular effects outside the Crooke's tube spring into prominence. The crackling spark outside the tube is far-reaching in its effect, yet it shows no signs of the X rays, its light can not penetrate the human body, it excites only a feeble phosphorescence at a distance of even two or three feet, while the same energy excited in the Crooke's tube can cause luminescence at a distance of twenty feet. The crackling spark, however, can be seen much farther than the light of the Crooke's tube, and it can also impress a photographic plate at much greater distance. The following experiments will illustrate the different manifestations of energy of which an electrical discharge is capable. I produced an electrical spark about six inches in length and exposed a photographic plate for six seconds, at a distance of two, ten, and twenty feet, to its light. A thin strip of tin, with a circular hole cut in it, served as a shutter. The sensitive plate was thus protected, except in front of this aperture. The images exhibit the decrease in light with the increase of distance. Another portion of the sensitive plate was exposed in the same manner during the same length of time to the light of a Crooke's tube which was excited by this same spark. No image was obtained at a distance of ten feet, and barely one at three feet. The spark in air, therefore, was far more energetic

photographically than the X rays, but it could not penetrate solid materials. This property was given to it by its passage through rarefied space. I then covered a screen with a phosphorescent substance, and exposed it to the spark in air. The phosphorescent light could barely be detected at a distance of three feet, while with a spark in rarefied air it could be seen at a distance of twenty feet.

When we consider these experiments we see that the X rays act toward phosphorescent matter much as the spark in air behaves toward the photographic plate. Now, these results, taken in connection with the strong electrical effects in the neighborhood of an excited Crooke's tube, points to a certain connection between phosphorescence and electricity. Can it be that the strange light is excited by very short electrical waves sent out from the tube, which can not travel far but are very active in producing molecular effects? This activity, indeed, may prevent their extending to great distances. Wireless telegraphy evidently depends upon one set of waves sent out by a spark, and X-ray photographs upon another set developed only in rarefied air. Phosphorescence can not be produced with ease by the spark in air. On the contrary, it is developed to a remarkable degree and at comparatively great distances by the discharge in rarefied air. It has been shown by Mr. Burbank and myself that electrical force can develop phosphorescent light in certain crystals. The sunlight can do the same. Is sunlight an electrical phenomenon? That it is constitutes the greatest hypothesis in physics of this century. When we reflect, too, that the phosphorescence of the firefly is excited by some manifestation of a living organism—nerve force or some related force—shall we not include nerve force in the electrical category?

The X rays, therefore, bring into prominence strange lights which had heretofore been noticed chiefly by keen-eyed investigators, and which, with their names, phosphorescence and fluorescence, were unknown to the bulk of mankind. The fluorescent screen, by means of which surgeons observe the skeleton of the body, has now taken its place in medical practice with the stethoscope, by which the mechanism of the lungs is studied, and hopes have been excited that the blind may yet use the X rays in detecting objects and in regaining a sense of vision, even though this sense may be only partial. It is a curious fact that the retina of the eye is phosphorescent and fluorescent, and that one can see the shadow of certain objects in the dark when one stands so that the feeble X rays fall upon the eye. In other words, the retina acts as a fluorescent screen. The eye at present recognizes only a limited number of the waves that are surging about us. We can

see the colors from red to violet, but the dark colors, so to speak, formed by waves longer than $\frac{1}{40000}$ of an inch and shorter than $\frac{1}{1000000}$ of an inch make no recognizable impress upon our retina, unless, indeed, they constitute telepathic signals which apparently stir our consciousness and make us believe that friends are communicating from a distance. The electrical discharge has lifted, so to speak, a realm of short waves of energy out of the darkness and made them visible. Can the human brain be made conscious of other waves which fill space?

But we have not by any means exhausted the protean manifestations of the X rays. Besides the photographic, the phosphorescent, and fluorescent effects, there are still more singular properties of these rays. One of the most striking consists in their opening a path for a current of electricity. The electrical discharge, feeble in itself, not capable of lifting by means of a motor a pound weight a foot from the floor, is yet competent to open a path for a current which can set all the trolley cars of a great city in motion. To exhibit this mysterious effect we bring the ends of the electrical current which we wish to excite near each other, but not touching, in a glass tube with thin walls, from which the air has been exhausted. When the X rays fall on the gap between the wires the electrical current immediately jumps across the gap with a vivid light. We have here the mechanism of an electrical relay—the feeble energy of the electric discharge can call into play a giant energy. By what energy does it accomplish this? Is it by compelling molecules to put themselves in line, so that the electrical current can bridge the gap? Is it by breaking down this mysterious ether of space, as if we threw a stone at a turbid bull's eye in a prison chamber and let in a flood of sunlight? How the imagination is stirred by this process, what seems dead and lifeless can, by a physical agency, be stirred to endless activity! The rays are like the touch of Ithuriel's spear.

The electrical discharge can accomplish all this, but the story of its activity is not yet told. It can not be told, for each year adds information in regard to these activities, for there are thousands of investigators at work. Another far-reaching manifestation is this: the rays can separate the air or a gas into its constituent particles, much as a strong electrical current separates water into oxygen and hydrogen. They can communicate electrical charges to these particles—positive and negative charges. The charged air-particles, when forced through partitions of spun glass, does not give up their electricity as they do when they are charged by an electrical machine. This curious manifestation leads me to suspect that the electricity and magnetism of the earth may be

caused by an X-ray effect on our atmosphere. The sun and the earth are separated like the terminals of a Crooke's tube—two conductors with a vacuum between. An electrical excitation from the sun may cause an electrical discharge between it and the earth. This discharge might consist of an X-ray effect which could separate the upper layers of the atmosphere into positive and negative charges. The velocity of the negatively charged particles is greater than that of the positively charged ones, and the revolution of the earth may cause such a movement of these electrified particles that electrical currents may be generated which in circulation around the earth could produce the observed magnetism of the north and south poles, together with the auroral lights characteristic of those regions. This, I am well aware, is an audacious theory. It is certainly a vast extension of the laboratory experiments I have described, but the electrical radiations developed in electrical discharges are as competent to produce powerful magnetic whirls as the heat radiations in our atmosphere to develop cyclones. In the lower regions of our atmosphere the air is an insulator like glass to the passage of an electrical current. A layer a foot thick can prevent the circulation of the most powerful current which is now used to generate horse power. When this air space is rarefied at a certain degree of rarefaction the electrical current passes, especially, as we have seen, if it is illuminated by the X rays. When, therefore, we ascend to a height of ten or twenty miles the rarefied air becomes an excellent conductor of electricity of high electro-motive force. To my mind the conditions exist for developing an electrical state in the earth's covering of air, which is competent to explain the electrical manifestations of the air, the auroral gleam, and the mysterious effect on the magnetic needle which keeps it directed to the magnetic north. Can not we conclude that the study of the X rays bids fair to greatly extend our conceptions of the constitution of matter and of the action and interaction of Nature's forces?

A Himalayan explorer reported, a few years ago, that he had seen, from one of the lofty summits of the Mount Everest district, a peak which, beheld in the same view with Mount Everest, was evidently higher than it. Nothing has been heard of the matter since then till the recent appearance of Major L. A. Waddell's book, Among the Himalayas. This author, who has explored the same region, represents that the Tibetans there say there is another mountain, due north of Mount Everest, that exceeds that peak in height, thus confirming the story of the former Alpinist. It appears that Mount Everest is not called Gaurisankar or Deodunga, as some affirm, but that the Tibetan name of the culminating peak of the group is *Jomo-kang-kar*—"The Lady White Glacier."

A HUNDRED YEARS OF CHEMISTRY.

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IT is hardly an exaggeration to say that chemistry, as a science, is the creation of the nineteenth century. Chemical facts, indeed, were known even in remote antiquity; some principles were dimly anticipated long before the century began; Boyle had given the first rational definition of an element; the principal gases had been discovered; great foundations were laid, ready for the superstructure. But the making of bricks is not architecture, nor does the accumulation of details constitute a science. The scattered facts are needful preliminaries, but only with the discovery of laws and the development of broad generalizations does true science begin.

That truth can be born from error may seem paradoxical, but, nevertheless, the statement is exact. False hypotheses stimulate investigation, and so truth comes at last to light. In the history of chemistry this principle is clearly illustrated. During the eighteenth century the doctrine of phlogiston was generally accepted; this led to exhaustive researches upon combustion, and from these the science of chemistry received its present shape. Becher and Stahl had taught that every combustible substance contained a combustible principle—*phlogiston*—and that to the elimination of this principle the phenomena of combustion were due. According to this theory, a metal was regarded as a compound of its calx, or oxide, with phlogiston; hydrogen became a compound of water with phlogiston, and so the truth was curiously inverted. The doctrine was vigorously and ingeniously defended, and, although it was overthrown by Lavoisier, it had persistent supporters even after the present century began.

The weak point of the phlogistic theory was its practical disregard of the phenomena of weight. That the calx weighed more than the metal was well known, but quantitative considerations were subordinated to those of quality, and the form of matter was studied rather than its mass.

In 1770 the scientific career of Lavoisier began, and the balance became a chief instrument in chemical research. The constancy of weight during chemical change was experimentally established, and what had been a philosophical speculation—the increatability and indestructibility of matter—became a doctrine of science, a datum of knowledge instead of a hypothetical belief. In 1774 Priestley and Scheele independently discovered oxygen, and with

the aid of the balance the phenomena of combustion were rendered intelligible. The foundations of chemistry were laid, and upon them the nineteenth century has built. Lavoisier, the greatest of the founders, fell a victim to the guillotine; the judge who condemned him refused all appeals for mercy, saying "the republic has no need for *savants*," but the necessity which judicial ignorance could not foresee presently made itself felt. France, at war with all Europe, her ports closed to supplies from without, fell back upon her own resources. Saltpeter was needed for her guns, alkali for her industries, and the chemist was called upon for help. The stress of continued warfare stimulated intellectual activity, and one result was the creation of chemical processes which revolutionized more than one industry. The dependence of modern civilization upon science then began to be recognized—a dependence which is, perhaps, the chief characteristic of the present century.

With the opening of the new century a period of great activity began. The constancy of matter was well established, and the fundamental distinction between elements and compounds was clearly recognized; two starting points for exact research had been gained. Only a small number of elements, however, had been identified as such; of some substances it was doubtful whether they were elementary or not, but the mine was open and a rich body of ore was in sight. Furthermore, the utility of research had become evident, so that intellectual curiosity received a new stimulus and a new direction. Theory and practice became partners, and have worked together to this day.

Between the years 1803 and 1808 one of the greatest advances in scientific chemistry was made, when John Dalton announced and developed his famous atomic theory. In this we find a notable illustration of the difference between metaphysics and science. The conception of matter as made up of atoms, as discrete rather than continuous, was a commonplace of philosophical speculation. It had been taught by Democritus and Lucretius; it was the theme of wordy wrangles during centuries; Swedenborg, Higgins, and other writers had sought to apply it to the discussion of chemical phenomena; but it remained only a speculation, unfruitful for discovery. Up to the time of Dalton it had led to nothing but intellectual gymnastics.

A good scientific theory is never a product of the unaided imagination; it must serve some purpose in the correlation of phenomena which suggest it to the mind. This was the case with Dalton's discovery, which grew out of his observations upon definite and multiple proportions. That every chemical compound has a fixed and definite composition was recognized by Lavoisier, and by

other chemists before him; but the fact was disputed by Berthollet, and its verity was not established until 1808. Dalton went a step further, and found that to every element a definite combining number could be assigned, and that when two elements united in more than one proportion even multiples of that number appeared. Thus, taking the hydrogen weight as unity, oxygen always combines with other elements in the proportion of eight parts or some simple multiple thereof, and so on through the entire list of elementary bodies. Each one has its own combining weight, and this was the law for which Dalton sought an adequate explanation. Fractions of the weights did not appear, fractional atoms could not exist; the two thoughts were connected by Dalton. Chemical union, to his mind, became a juxtaposition of atoms, whose relative weights were indicated by their combining numbers, and so the atomic conception for the first time was given quantitative expression. The facts were co-ordinated, the special laws were combined in one general theory, and the mere suppositions of other men were supplanted by a precise statement, which is a corner stone of chemistry to-day. The doctrine led at once to investigations, it rendered possible the discovery of new truth, chemical formulæ and chemical equations were developed from it; without its aid the growth of chemical science would probably have been slow. The nature of the atoms may be in doubt, they may be divisible or indivisible, but the value of the theory is independent of such considerations. It gives adequate expression to known laws, and it can only be set aside, if ever, by absorption into some wider and deeper generalization.

The same year which saw the completion of Dalton's theory (1807) was also signalized by the remarkable discoveries of Sir Humphry Davy, who decomposed the alkalies and proved them to be compounds of metals. In 1810 chlorine, which was previously thought to be a compound, was proved to be elementary, and this fact was emphasized a year later by the discovery of iodine. These researches gave precision to the conception of an element, and prepared the way for later investigations upon many other oxides. All the so-called "earths"—lime, magnesia, alumina, and so on—were now seen to be oxy-compounds of metals, and an intelligent interpretation of all forms of inorganic matter became possible. The first step in the chain of research was the discovery of oxygen itself: from that, and from the teachings of Lavoisier, the later discoveries logically followed.

While the investigations of Dalton and of Davy were still incomplete, other chemists were actively studying the properties of gases and exploring the fertile border-land between chemistry and

physics. In 1805 Gay-Lussac and Humboldt determined the composition of water by *volume;* in 1808 Gay-Lussac extended these observations, and found that in all compound gases simple volumetric relations existed; and in 1811 the entire subject was generalized into Avogadro's law. Avogadro showed that equal volumes of gases, compared under equivalent conditions, must contain equal numbers of molecules, and although the force of his discovery was not fully appreciated until much later, it is now recognized as one of the fundamental propositions of both physics and chemistry. For the first time the distinction between atoms and molecules was clearly stated, and from the density of a gas the relative weight of its molecule could be calculated. Avogadro's law rounded out and completed the atomic theory, and to its application much of the advance in organic chemistry is due. Equally striking, but less far-reaching in its consequences, was the discovery announced by Dulong and Petit in 1819, when it was shown that the specific heat of an element was inversely proportional to its atomic weight. Otherwise stated, this law asserts that the atoms of all the elements have the same capacity for heat, and an important check upon determinations of atomic weight was thus provided.

The next twenty years in the history of chemistry were years of detail rather than of permanent generalizations. The multitudinous verification of known laws, the development of experimental methods, especially methods of analysis, the discovery of new elements, the preparation of numberless new compounds, occupied the attention of most workers. This period, which may be called the Berzelian period, was enormously fruitful in results, although but few of the theories then proposed have survived to the present day. During this period the name and influence of Berzelius overshadowed all others, and his marvelous researches, carried out in a laboratory which was hardly more than a kitchen, were of almost incredible variety. For the crude symbols of Dalton, Berzelius substituted a system of chemical formulæ which could be used in chemical equations; in 1818 and 1826 he published tables of atomic weights, determined with far greater exactness than ever before; he discovered five new elements and a multitude of compounds, devised methods of research, and proposed theories which, though later to be overthrown, for many years dominated chemical science. His electro-chemical experiments led him to his dualistic theory of compounds, which interpreted each compound as made up of two parts—one positive, the other negative. The electro-positive oxides were basic, the electro-negative groups were acid; chemical affinity was electrical attraction between the two opposites; chemical union implied a neutralization of one by the

other. These ideas were more than speculation, for they rested upon experiment and led to further experimental research; but they went too far, and therefore could not last. The theory, however, contained much that was true, and the formulæ developed by it gave the first general suggestion of what is now known as chemical structure or constitution. The later study of organic compounds led up to the modern views.

Although Berzelius and many other chemists did some work upon organic compounds, their era was chiefly identified with inorganic researches. Mineral chemistry received a great deal of attention, the relatively simple acids, bases, and salts were studied, but the compounds of carbon were thought to be more complex and received less consideration. To-day, at the close of the century, nearly seventy thousand organic compounds are known, and of these comparatively few were discovered before the year 1830. Since then organic chemistry has been the dominant line of investigation.

Among the earlier chemists of the nineteenth century it was commonly supposed that organic and inorganic matter were radically different, and that the former could only be produced by the operation of a peculiar vital force. To this view there were some dissentients, Berzelius among them, but experimental proof for their contention was lacking. In 1827, however, Wöhler succeeded in transforming the inorganic ammonium cyanate into the organic urea, and the barrier was broken down. The era of synthetic chemistry had begun. Still earlier, in 1823, Liebig had found that silver cyanate and silver fulminate possessed the same percentage composition; in 1825 Faraday discovered an isomer of ethylene; and Wöhler's research now gave a third example of the same kind. Two different substances could contain the same elements in the same proportions, and to explain this fact Berzelius inferred different arrangements of atoms within the molecule, and suggested that their mode of union might be determined. A working theory, however, was still lacking, and without it progress was necessarily slow. The dualistic hypothesis explained the phenomena only in part, and as the known facts increased in number it had to be abandoned.

Two important investigations paved the way for an advance. In 1832 Liebig and Wöhler, studying benzoic acid, found that it and its derivatives contained in common a group of atoms, not isolable by itself, to which they gave the name of benzoyl. The conception of such a group, a compound radicle, already existed, but it lacked clearness, and now for the first time it became truly a scientific idea. The search for, and the identification of, compound

radicles began to occupy the attention of chemists, and a definite line of attack upon organic matter was recognized.

Two years later the second great step was taken. Dumas, studying the action of chlorine upon acetic acid, showed that the chlorine could replace hydrogen atom for atom, or volume for volume, and that his observations explained other reactions which had been unintelligible hitherto. This research led him to the famous theory of substitutions, which at first was received with ridicule, but soon found general acceptance. Electro-chemical conceptions, the Berzelian doctrines, were then in vogue, and it seemed strange, even absurd, to suppose that electro-negative chlorine could be substituted for electro-positive hydrogen. But the facts were stronger than the preconceived ideas, and the latter soon gave way. In this discovery by Dumas the first germs of the modern theory of valence are to be found.

For the study of inorganic substances, however, the dualistic theory was long retained, with the result that inorganic chemistry degenerated to a great extent into analysis and compound making, without any general conceptions which could stimulate scientific advance. It became a science of details rather than of principles, and was soon overshadowed by the organic branch. In the latter, theory after theory sprang up, flourished, and died away, each one having partial truth, but none being exhaustive and final. Still, the intellectual activity led to discoveries, and the warfare between doctrines, unlike the warfare between men, was productive of good instead of destruction. From the conflict of ideas the truth gradually emerged, and a new system of chemical philosophy was developed. The theory of compound radicles, the nucleus theory, the theory of types, the conception of conjugated compounds, followed rapidly one after the other, until in the discovery of valence all discrepancies were reconciled, structural chemistry came into existence, and a single doctrine, applicable alike to organic and inorganic substances, had possession of the field.

The theory of valence was a logical outgrowth from its predecessors, whose valuable features it included in a wider generalization, but it was the work of no one master mind. Many chemists contributed to its up-building, Frankland and Kekulé being among the leaders; but its foundations are to be detected in the atomic theory itself, from which it is legitimately derived. To understand its full significance we must take a step backward in history, and trace the change in atomic weights from their first form to the modern system.

In the early days of the atomic theory, in the determinations by Wollaston, Berzelius, and others, attention was chiefly paid to

the atomic weights in their aspect of combining numbers. They were primarily of use as factors in chemical calculations, and chemists naturally sought for their simplest expressions, with little regard to theoretical considerations. The laws of Avogadro, of Dulong and Petit, had, indeed, been announced, but the adjustment of the atomic weights to meet their requirements was long neglected. The importance of the adjustment was not realized, for it was obscured by the prevailing dualistic theory, but without it the deeper general relations of the atoms could not appear. Accordingly, a system of chemical formulæ grew up which was based upon a deceptive apparent simplicity of ratios, and by which the theory of valence could not be even suggested. The old formula for water, HO, expressed only its composition by weight, ignoring its composition by volume; it failed, therefore, to accord with Avogadro's law or to give the slightest hint as to the relations which are now covered by the conception of chemical structure. A part of the existing knowledge was accurately symbolized, but the larger part was ignored, a state of affairs which could not last, although the change came about but slowly.

The incentive to reform came from two sources. Physics, in the kinetic theory of gases, gave a new demonstration of the truth of Avogadro's law, and led chemists to realize more clearly than before the distinction between atoms and molecules. Soon it was seen that the molecule was the smallest particle of matter which could exist as such, while the atom was the smallest particle which could take part in any chemical change. The metaphysical atom was really the modern molecule; the chemical atom was a new conception, due to the discoveries of chemistry alone. This distinction was found to hold good even for elementary bodies, and it became evident that free hydrogen or oxygen must contain two atoms to the molecule, while phosphorus and arsenic contained four. With mercury the atom and the molecule are identical, but in most cases the greater complexity exists, and the elements as we see them are compounds of like atoms with each other. That hydrogen can unite with hydrogen, oxygen with oxygen, carbon with carbon, is a conception to which the early chemists never attained, but which is a necessary consequence of Avogadro's law in its application to observed phenomena.

The second impulse toward change originated in the study of organic compounds, and gained its force from the struggle between contending theories. The advocates of each theory sought for evidence in its favor, and so innumerable discoveries were made, compound radicles were recognized in great numbers, and the mass of data became so overwhelming that for a while chaos reigned.

Classification of compounds became imperatively necessary, and to that all speculation was subordinated. In 1842 Schiel found that the alcohols formed a regular series, with progressive variation in their properties; Dumas observed a similar relation among the fatty acids, and so something like order began to appear.

In 1843 Charles Gerhardt proposed to use the law of Avogadro as a basis for the determination of atomic weights. This involved the doubling of many existing values, especially the atomic weights assigned to oxygen, carbon, and sulphur. At first the proposition was violently opposed, and even ridiculed, but by slow degrees it managed to make its way, although it was not until after 1858 that it began to find anything like general acceptance. In that year Cannizzaro put forth his revision of the atomic weights, adjusted to accord with physical laws, and a new era in chemistry began. The modern theories of chemistry became possible, and the many researches in which they had been foreshadowed received a clearer meaning. Cannizzaro did not stand alone; his work was but the capstone of a structure which had long been growing; Liebig, Dumas, Laurent, Gerhardt, Wurtz, Graham, Williamson, and Frankland were among the builders. But at last chemical and physical evidence were brought into full convergence, and each gave emphasis to the other.

During the formative period of the new doctrines, between 1840 and 1858, many discoveries were made which helped toward the final consummation. Even earlier than this the researches of Graham upon the phosphoric acids had familiarized chemists with the idea that different substances might have very different combining powers, and other polybasic acids were found to exist among organic compounds. The discovery by Wurtz, in 1849, that the hydrogen of ammonia was replaceable by organic radicles, forming the compound ammonias or amines, was a logical extension of the theory of substitutions; and the recognition at about the same time, by Hofmann, of ammonia as a distinct type upon which many other substances could be modeled, was another long step forward. In 1851 Williamson argued that nearly all inorganic and many organic molecules could be represented as analogous in structure to water, and a year later, as a result of his researches upon the organo-metallic bodies—zinc ethyl, tin ethyl, etc.—Frankland expressed the belief that every elementary atom has a definite combining power which limits the number of other atoms capable of direct union with it. This was the theory of valence in its first and simplest form, undeveloped to its consequences, but unmistakably clear. To carbon compounds in general it was yet to be applied.

In 1858 the work of Cannizzaro appeared, and a general revision of chemical formulæ became necessary. The advanced views which a few chemists had held began to find a more general acceptance, and the significance of the change was gradually realized. In the same year Kekulé showed that the atom of carbon had a combining capacity of four, and furthermore that in many organic compounds the carbon atoms were in part united with each other, and even linked, as it were, into chains. Still later, studying benzene, he found that its six carbon atoms were best regarded as joined together in the form of a closed ring, and with this conception the idea of chemical structure received at last a definite form. These linkages of atoms, these rings and their derivatives, could all be represented graphically to the eye, in accordance with the combining power of the several elements, and so the structural formulæ of modern chemistry came into vogue. Types, substitutions, compound radicles, were all covered by and included in the new generalization, and each of the older theories was seen to be but an expression of special cases, rather than of any general law. No truth was set aside, but all were co-ordinated.

To the non-chemical reader the foregoing passages may seem vague and abstruse, but in an essay of this scope greater elaboration is inadmissible. It is clear, however, that each forward step has been a logical development of the atomic theory, which, as we shall see later, does not end even here.

Thus, then, the chemical formulæ and atomic weights of Berzelius grew by slow degrees into the modern system, with its representations of structure and atomic linking. The internal architecture of the molecule was now revealed not to the imagination only, but to the eye of reason, and, speculative as the new conceptions may seem at first, they have led to astonishing practical consequences. The new formulæ at once indicated lines of research, and with their aid synthetic chemistry was greatly stimulated. True, many syntheses of organic compounds had already been made, but progress became more rapid and the work of discovery was systematized to a wonderful degree. In 1856 Perkin discovered the first of the coal-tar dyes, creating a new industry which has been assisted beyond measure by the structural symbols that came into use only a few years later. In 1868 alizarin, the coloring principle of madder, was made artificially from the hydrocarbon anthracene; a host of other colors, a veritable chemical rainbow, have been discovered; the synthesis of indigo has been effected: and within twenty years we have seen medicine enriched by a great variety of drugs, all prepared by purely chemical processes from the former waste material—coal tar. To most of this work, at

least since 1865, Kekulé's conception of the benzene ring has been the guiding clew, and it is certain that without the theory the practice would have advanced much more slowly. Out of research for its own sake has come an enrichment of the world, which in any previous age would have been inconceivable.

The atomic theory, while replacing speculation in one sense, stimulated it in another. The human mind is always striving to get back of the known, to see what lies beyond the limits of visibility, and the conception of an element with its atomic weight opened up a field for the exercise of the imagination. What is an element ultimately? was an early question to ask. Are the elements really diverse, or do they manifest but one fundamental kind of matter? To such queries the atomic weights offered a promising line for investigation, and more than one mind began traveling along it. In 1815 Prout put forth the supposition that all atomic weights were even multiples of that assigned to hydrogen, and over this hypothesis a long warfare has raged. To-day it is practically abandoned by chemists, but the controversy which it provoked led to some of the most accurate investigations in the history of science, and so served to give precision to our knowledge. Without the instigation of Prout's hypothesis, which hinted at hydrogen as the ultimate form of matter, we might have been content with inferior determinations of atomic weight, and chemistry, as an exact science, would have suffered.

In due time, however, it was perceived that the elements could be arranged in groups, the members of each group having similar properties and forming similar compounds. Serial relations, analogous to those discovered among organic compounds, became manifest, and much thought was expended in seeking to trace out their meaning. The classification of the elements was more and more seen to be important, and regularities came to light which at first were unsuspected. Still, no general law, no one guiding principle, could be found so long as the old system of weights and formulæ was retained in common usage.

The adoption of Cannizzaro's atomic weights and the establishment of the theory of valence made possible a new attack upon the problem of classification. In 1864 Newlands arranged the elements in the order of their atomic weights, and showed that at regular intervals there was a periodic recurrence of certain characteristics. This observation, which foreshadowed the periodic law, was received with indifference and, to some extent, with ridicule, but the path had been found which soon led to a great discovery. In 1869 Mendelejeff published his celebrated memoir, and the periodic law took its place as a distinct addition to science. Almost

simultaneously Lothar Meyer announced similar views, but independently, and controversy soon arose as to the relative merits of the two philosophers. With that controversy we have nothing to do, but the law itself deserves our fuller attention.

According to the periodic law, all the properties of the elements are periodic functions of their atomic weights, varying from substance to substance in a perfectly regular manner. The elements thus fall into periods, or octaves, as Newlands called them, of a very striking character. If, for example, we start with univalent lithium, the next higher element has a valence of two, the next of three, and then comes carbon, whose atom is quadrivalent. Following carbon, the combining power of successive elements decreases until we reach sodium, in which something like the properties of lithium recur. Above sodium the same rise goes on to the fourth element higher, silicon, which resembles carbon, and then follows the regular step-by-step falling away, to end with chlorine, the last member of the second period. This periodic rising and falling is characteristic of all the elements, and they were so tabulated by Mendelejeff as to be perfectly clear, with a clearness which is not to be given by words. In Mendelejeff's table certain gaps appeared, which he ascribed to the existence of undiscovered metals. For three of these he predicted the properties, starting out from the properties of their neighbors. This was a rash thing to do, but the venture has been fully vindicated. In 1875 Lecoq de Boisbandram discovered gallium, which filled one of the gaps; scandium and germanium filled the other two later. The predictions of Mendelejeff were fulfilled; atomic weight, specific gravity, fusibility, the character of the compounds to be formed, were all foreseen for each of the three new elements; and, so far as experiment has yet gone, his anticipations have been perfectly realized. Every good theory is prophetic; but few generalizations have been so strikingly verified in this respect as has the periodic law. In spite of some outstanding difficulties, yet to be explained, the law has served to great advantage in the classification of the elements, and it has had much to do with the late revival of inorganic chemistry. The latter branch of science, long comparatively neglected, has now gained new interest, and for it, in the near future, a great growth can be prophesied.

The immediate effect of the periodic law was to prove that the elements are connected with one another by general relations, and so to stimulate the belief in their possibly common origin. This view has many upholders, although it is also strongly opposed, but the weight of argument seems to be in its favor. On philosophic grounds it is at least more probable than the opposite opinion.

which can not account in any way for the regularities which have been observed. From another source, partly physical and partly chemical, the theory of the unity of matter has received strong support, and this statement brings us to another of the greatest discoveries made during the nineteenth century—that of the spectroscope and spectrum analysis.

It was in 1860 that Kirchhoff and Bunsen added this new weapon to the arsenal of scientific research. The spectroscope itself, as an instrument, was an invention in the department of optics, but its applications to chemistry were among the most obvious and the most startling of its achievements. With its aid new elements were discovered—rubidium, cæsium, thallium, indium, and gallium; in many lines of investigation it found immediate use; but, more than all, it made possible the analysis of the heavenly bodies, and proved that the same kinds of matter exist throughout the visible universe. Before the day of the spectroscope all speculation upon the chemistry of the stars was in vain; with its advent the material unity of planets, suns, and nebulæ was made clear. To the astronomer, a new eye was given; to the chemist, a new laboratory. Three sciences were brought to a single focus, and each one gained in power thereby.

In its application to what may be called chemical astronomy, one achievement of the spectroscope was particularly notable—namely, the rehabilitation of the nebular hypothesis. When the gigantic telescope of Lord Rosse had resolved some nebulæ into clusters of stars, it was thought that all other nebulæ might be of the same character; the visible basis of the hypothesis was gone. But the spectroscope soon found among these celestial objects some which were truly clouds of incandescent gas, and so the nebular hypothesis received a new standing, becoming stronger than ever before. One point, however, was strange: these gaseous clouds were of the simplest composition; hydrogen and nitrogen were their chief constituents; how, then, could a world like ours originate from them?

Further investigation, to which Huggins and Secchi were the chief contributors, showed, however, that from nebula to planet there is a regular, progressive order of chemical complexity. The nebulæ are simple; in the hotter stars a few more elements appear; more still can be detected in colored stars and the sun; but the planets, represented by our earth, are most complex of all. So far the facts; the scientific imagination now comes into play. If suns and planets were derived by a process of condensation from such nebulæ as exist to-day, perhaps the process of evolution was attended by an evolution of the chemical elements themselves.

Upon that supposition the facts become intelligible; without it the evidence is not easily co-ordinated. This hint, together with the suggestions offered by the periodic law, has made chemists more ready to consider the probable unity of matter, even though actual proof for or against the conception has not yet been attained. That the chemical elements are absolute and final few thinkers of to-day believe; the drift of opinion is mainly in one direction, but no element has yet been decomposed or transmuted into another. Some mathematical relations have been found connecting the atomic weights of certain elements with the wave lengths of their spectral lines, and this field of investigation is a promising one for the future. That the atomic weights are connected hardly admits of doubt; to the mass of the atom its rate of vibration must be related; to that vibration the lines in the spectrum are due. The clews are obvious, and it will be strange if they do not lead to important discoveries ere long.

[*To be concluded.*]

THE SCIENCE OF ART FORM.

By D. CADY EATON.

TASTE is so free and so subjective, so largely a matter of personal feeling, that any selection or limitation of attractive objects would be met by plausible objection. Every honest and unprejudiced investigator must, however, admit nowadays that his individual taste may be informed and purified, and that he is under obligations to be ever ready to explain and to justify it. The day for the mere proclaiming of preference has passed. The proclamation must be accompanied by explanations which will satisfy others, if they do not convince them, and which will be clear to one's own understanding. The authoritative explanation, "I like this, I dislike that," will no more pass current nor carry weight. Science has sufficiently studied the sentiments and emotions to know that they, too, are subject to laws which must be acknowledged and obeyed. Excitations for which there is no reasonable accounting, no justifiable source, must be relegated to the domain of folly. The reason for everything that appertains to thought and emotion, if not apparent, must be exposed and presented. Artists must explain their works to vulgar understanding. Writers must make their criticisms plain to the humble intellect. The age in which we live takes nothing for granted, accepts no man's *ipse dixit*, hates shams, is intolerant of secrecy, hypocrisy, and fraud.

I propose in this article, by contrasting good and bad examples, to put before readers a few of the simplest elements of decoration. You can hardly fail to note the differences, and when once the eye has acquired the habit of discriminating there is no reason why there should not follow a growth in perception which will result in delightful and augmenting artistic enjoyment. No attempt is to be made to develop a system, nor, of course, to cover the whole ground of the subject. The object is simply to start perceptions in the right direction.

Almost all the ideas and the illustrations of this article are taken from a little work by Henri Mayeux, called *La Composition Décorative*. Henri Mayeux is Professor of Decorative Art in the École des Beaux-Arts in Paris. His work is one of the series of the *Bibliothèque de l'Enseignement des Beaux-Arts*, a series which should be among the very first works to be found in the library of every student of art.

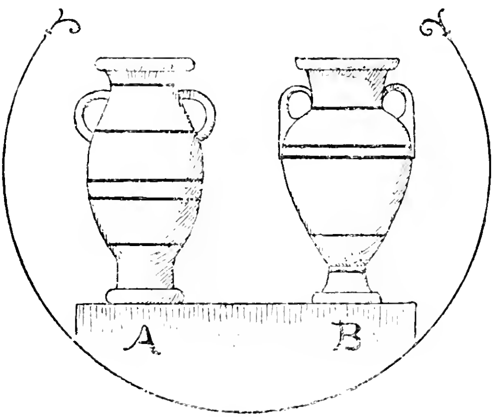


FIG. 1.

The very first of Mayeux's illustrations (Fig. 1) introduces the style of the teaching of the volume and of this article. Let me translate his accompanying description: "Here are two recipients of the same height, made of the same material, and with about equal care. Each has two handles and is decorated by the same number of fillets. The one marked *A* is the work of an ordinary potter, without artistic instinct or education. The other, *B*, is a Greek vase of fine and delicate taste. No one can fail to appreciate the superiority of *B* to *A*. The purity of its profile, the graceful manner in which the handles are attached, the calculated division of the fillets, establish at once a considerable difference of artistic value between the two objects." If Mayeux were addressing beginners he might add that one reason why all jugs and vases are round is that the shape is the easiest to make. The potter's wheel must have been one of the very earliest inventions of semi-civilized races. Besides, as a drop of water is globular, it seems appropriate that liquids should be contained in round receptacles. A square jug would not only seem inappropriate, but it would be ugly and perhaps difficult to handle. Notice in *B* how much better

the different parts are distinguished: the neck from the body of the vessel, and the body of the vessel from the foot. Two fillets are also very appropriately put where the vessel is largest, and where they seem to convey a sense of increased strength exactly where the pressure is greatest. You will find all the way through the study of ornament that utility, or use, is a fundamental principle which can not be violated without impairing beauty.

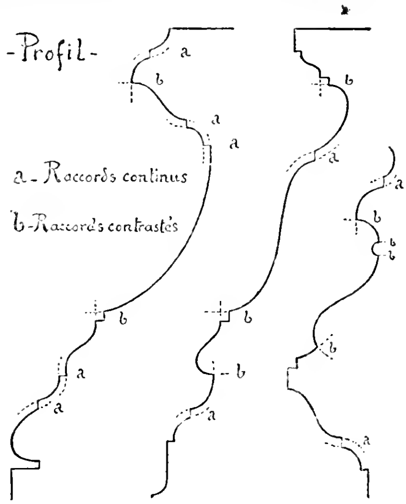


FIG. 2.

Before presenting objects for comparison it may be well to pass in review the elements which compose all objects. Decoration is the application of ornament to form. It therefore presupposes knowledge of both form and ornament, for form must be understood by itself, and ornament by itself, before the proper ornament may be selected for the given form. The elements of form are length, breadth, and thickness. A mathematical point is conceived to have no dimensions, a mathematical line but one, and a mathematical plane but two. But in actuality there is no tangible object without the third dimension—thickness. Still, where two dimensions are very much more prominent than the third—as, for instance, in a plaque, in the side of a room, in a single elevation of a building, or whenever merely the surface of an object is viewed—the third dimension may be left out of consideration. Lines and the surfaces they bound—that is, length and breadth—are the two elements of form which play the chief part in decoration.

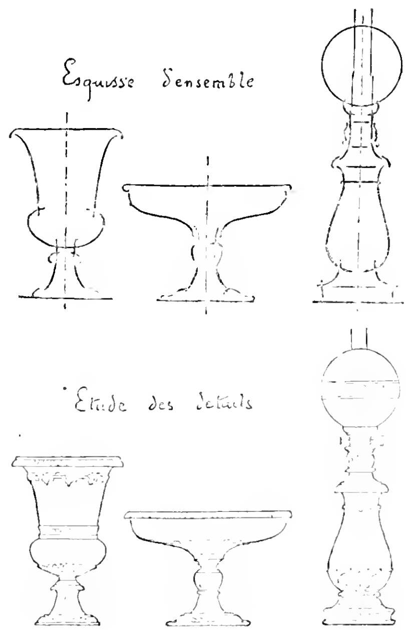


FIG. 3.

If the two vases which are represented in the view by vertical and horizontal, straight and curved lines, were actually before us you would have difficulty in finding any vertical lines, and the horizontal lines would turn out to be circles. The lines in the view mark the apparent terminations of the surfaces. For purposes of study, however, you must regard objects of three dimensions as bounded by lines, just as they appear in photographs, drawings, or other flat representations, geometric or perspective. In regarding objects from the point of view of decoration there is still another element to be considered; that is, the element of material, the substance of which objects consist, for it is evident that the ornament which would be appropriate to wood, for instance, might not be appropriate to metal or to stone. The element of material is of great importance in practical decoration, but of less importance in theoretical decoration. Lines and surfaces are therefore the two chief elements of decoration to be considered at present. Color, being an element of an entirely independent nature, will not be considered at all.

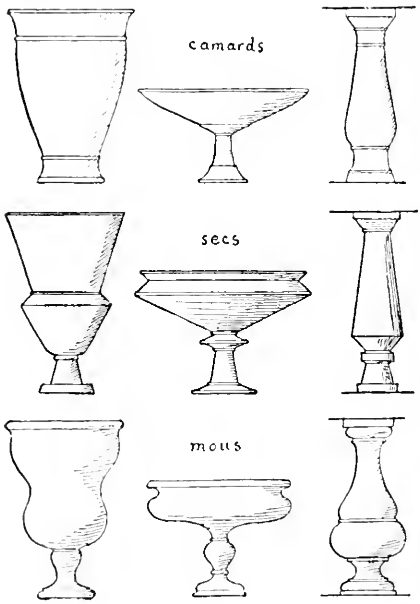


Fig. 4.

First, lines. The lines down one side of an object may be called the profile of the object, while the lines surrounding the object may be called the contour or outline of the object.

Profiles and outlines are made up of any number of straight and curved lines connected at any and every variety of angle. The view (Fig. 2) shows a few possibilities of combination of lines into profiles. The particular thing to be observed in these profiles is that individual curves are preceded or followed by curves which curve in the same direction or in the opposite direction—that is, regarding the curves as concave or convex from a given side of the profile, sometimes a concave curve meets a concave curve, sometimes it meets a convex curve. In these particular profiles the straight lines which unite the curves are so small and so insignificant that they appear as mere connections. Where the adjoining curves are homogeneous the connection is called con-

tinuous—*raccords continus*, as Mayeux puts it. When the adjoining curves are different, the connection is called contrasted—*raccords contrastés*. In the view all continuous connections are marked *a*; all contrasted connections are marked *b*. Now follow these lines up and down slowly and deliberately—not once or twice, but a number of times. See exactly where the connections occur,

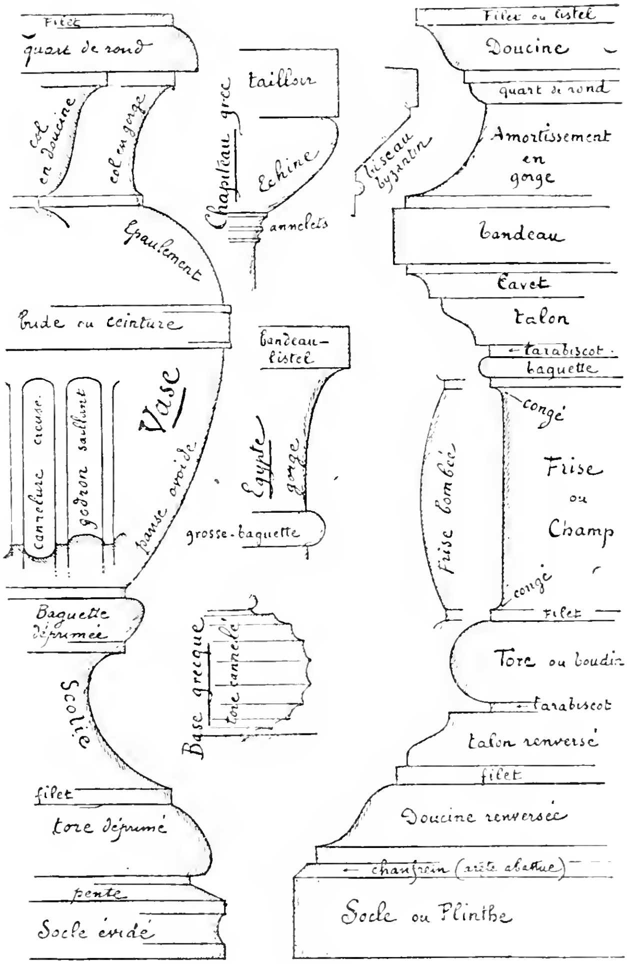


FIG. 5.

and where the connections are continuous, and where they are contrasted. In these profiles are shown forth and made evident two of the most important and general laws not only of ornament, but of all artistic composition: First, that connected curves of the same kind must run substantially in the same direction; and, second, that for purposes of strong contrast curves of different kinds must be

joined—that is to say, that where contrasted connection is desired, the difference in direction must be abruptly and sharply indicated. In the profiles in the view the various curves have been continued in dotted lines beyond the profiles, so as to bring out

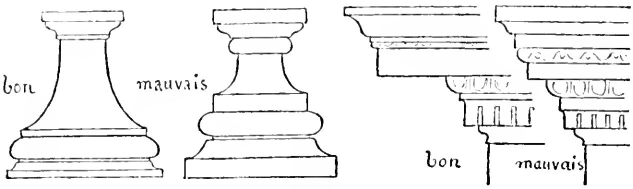


FIG. 6.

and make clear these two laws. You see that wherever there is a *b.* the dotted lines cross at, or nearly at, right angles, and that wherever there is an *a.* there is no crossing at all of the dotted lines. The essence of these two laws is of such importance in all artistic and decorative composition that beginners might well be put to drawing profiles until the principles involved have been absorbed and made a part of artistic apprehension. The profiles in the view are all pleasing, because the laws are observed. Try your hand at drawing profiles in which the laws are not observed, and you will quickly perceive the difference. The most beautiful of pure profiles are those presented by Greek entablatures. The most beautiful of Greek outlines are those presented by Greek vases. The beauties of Greek sculpture and of renaissance design belong so strictly to the domain of pure art that they may not be used for comparison in an article on ornament.

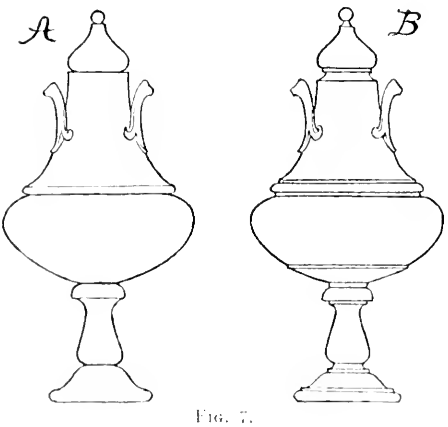


FIG. 7.

As outlines are composed of profiles, the same laws govern. That the curved line is the line of beauty stands out most evidently in the study of antique designs. Vertical lines and horizontal lines are the lines of support and strength, and must always have proper consideration; but in pure ornament the office of straight lines seems to be confined to connecting curves and to emphasizing their contrasts.

The next view (Fig. 3) is to illustrate the progress already made. On the upper line are the three rough outline sketches for

modern articles, of which the final use and destination are shown on the lower line. In the sketch to the left the fine effect is produced by a few curves, of which the connections are boldly and finely contrasted. In the second sketch an equally pleasing effect is produced by curves, of which the principal ones are continuously connected, while in the third sketch there is a pleasing exhibition of both kinds of connections. The lower line gives you your first

Contours bâtards et indécis.

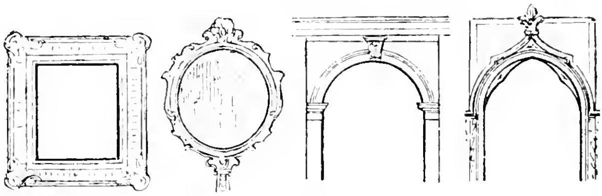


FIG. 8.

notion of the use of ornament in marking and embellishing the lines of form.

The next view (Fig. 4) exposes forms in which the above laws are violated, and by whose ugliness you can not fail to be impressed. On the top line are objects of which the curves are so weak and undecided that it would be difficult to state whether the connections are continuous or contrasted. In the second line is shown how ugly is the effect when straight lines are substituted for curved lines, and in the third line is shown how ugly effects may be pro-

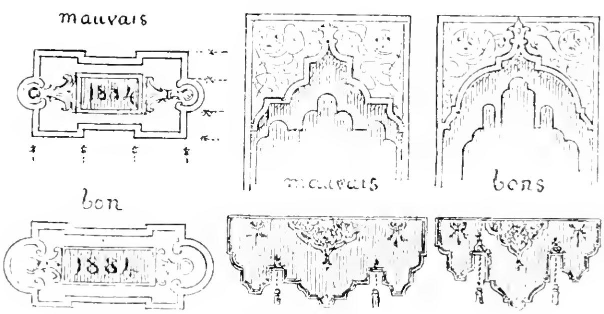


FIG. 9.

duced even by curved lines when not used in obedience to some accepted and apprehended principle.

There is another presentation of form which is in reality but a modification of profile, but which, because it looks as if it had been separately applied, and also because it is separately treated in books, must be considered by itself. The term "molding" has been given to variations in surfaces which have both useful and

ornamental uses. Moldings are as old as architecture, and vary with schools of architecture.

In the next view (Fig. 5), taken from Mayeux's work, are given the most ordinary Greek moldings with their French names. However necessary it must be for the architect, and however admirable it may be for the art student, to know the names of all moldings by heart and to be able to describe each one accurately, such proficiency is not required at present and is not necessary for the

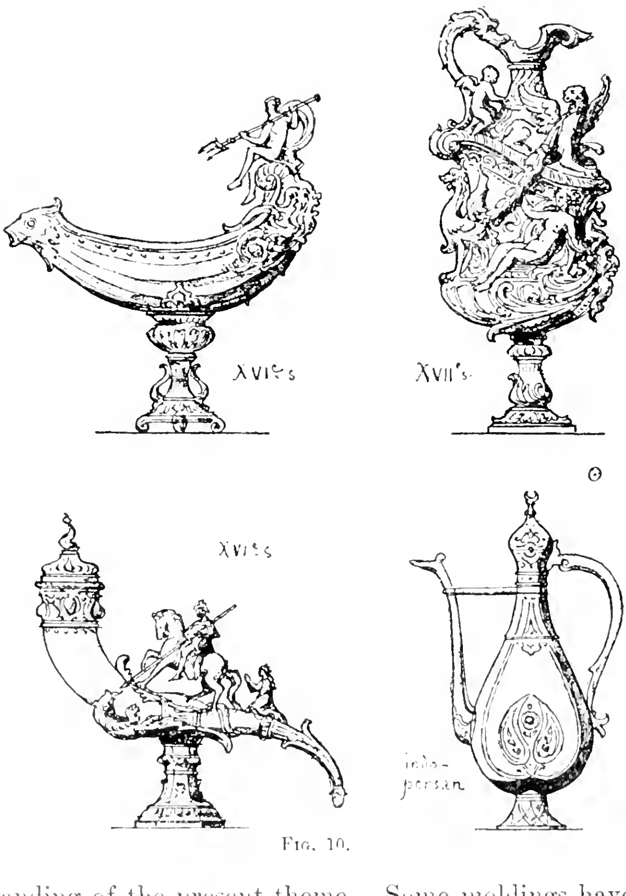


Fig. 10.

understanding of the present theme. Some moldings have square edges, some round. The curved edges of some are simple, of others complex. Each has its name, and of some the name is descriptive. The term molding would seem to indicate that moldings were made apart and subsequently applied to the main object. Whatever be the origin of moldings, the same rules apply to them which apply to other profiles, with the additional rule that moldings must always be kept subordinate to the principal object. For

instance, in the view (Fig. 6) the pedestal marked *bon* is good, because the body of the pedestal is the principal object and it is clearly seen that the moldings at the base and at the top are subordinate and merely ornamental, while the pedestal marked *mauvais* is decidedly bad, because more vertical space is given to the moldings than to the shaft, confusing outline, weakening the shaft, and destroying the sense of strong and steady support.

Readers may at once make use of the information already acquired by seeing how these rules apply to their own lamps, candlesticks, pieces of furniture, etc.

The next view (Fig. 7) shows incidentally how much better it is under all circumstances to mark with fillets and lines the changes

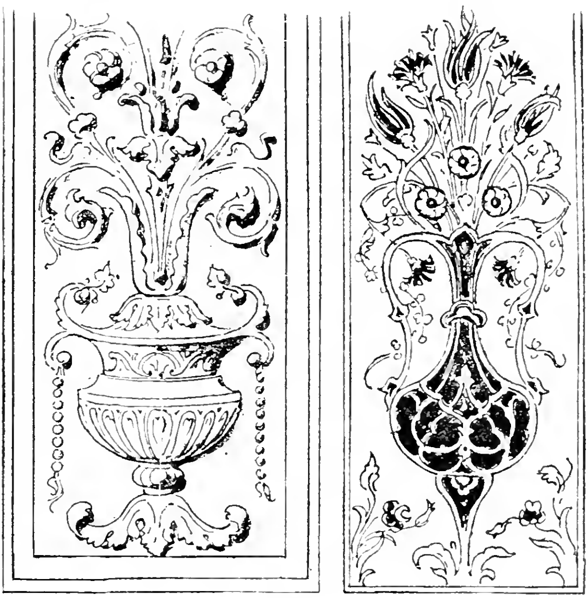


FIG. 11.

from one curve to another, for you certainly see how much more substantial character and beauty has *B* than *A*.

Finally, let it be said, and said emphatically, that though there are profiles which require the use of the compass to draw them, and though all architectural details must be worked out with mathematical accuracy, those profiles and outlines are the most beautiful where it is evident that artistic skill governing a free hand has controlled and where mechanical assistance is so subordinate as to be overlooked.

There is very little to be said about surfaces or forms of two

dimensions. The principal requirement is that outlines should be agreeable and must be well defined. In fact, the two qualities are inseparable, for a well-defined outline is agreeable and a badly defined one is sure to be disagreeable. By well-defined is meant that its particular shape should easily appear and be clearly distinguishable. For instance, a square should appear with sides distinctly equal; a circle should have but one center. In an architectural opening either arch or entablature should prevail, and the character of the arch should be evident. In the examples presented (Fig. 8) in the view these principles are violated. The first figure is so clearly a square that at first, and before you have examined it closely, you think it is a square. It leaves an indefinite and consequently disagreeable impression. The same criticism applies to the second object, apparently a mirror. The glass is round, but the frame is so irregular that the impress of the circle is destroyed, and there is left an undecided and therefore uncomfortable sensation. In the third example the arch is so poorly defined and so weak, while the entablature above it is so strong and so prominent, that the result is a composition that fails to give pleasure, because no distinct idea is conveyed. In the last example the outlines of the arch are so indefinite that its character is indistinguishable. You can not see which prevails, the round arch or the pointed arch.

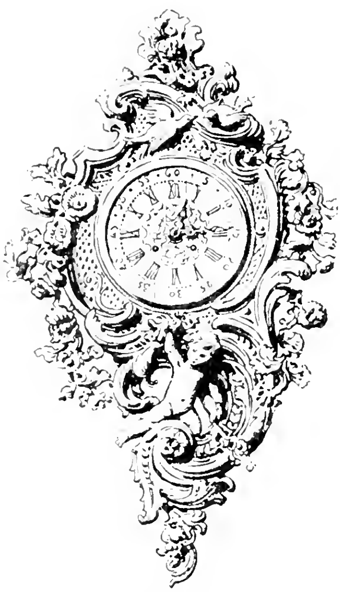


Fig. 12.

The same principles apply to smaller objects and to details, as seen in the next view (Fig. 9). To the left the date plate on top is bad in comparison with the one beneath it, because its direction is not so well marked and its corner projections are too large. In the lambrequins on the right, those are good in which the general direction is properly marked, and in which subdivisions are kept properly subordinated. Lambrequins have so entirely gone out of use nowadays that it is difficult to recall the time when they were regarded as indispensable parts of furniture.

There is one other point to which your attention should be called—that is, stability. If an object be intended to stand, its

center of gravity should be so well within its base that there will be no danger of its being upset by the ordinary uses to which it is exposed. Pots and pans, pitchers, lamps, and candlesticks, of general and daily household use, should have bases so broad and weight so low that the accidental bump of the inexperienced "help" will not be inevitably fatal.

When utensils are made more for show than for use, as those in Fig. 10, and are to occupy places of comparative security, beauty more than utility may be considered in the proportions of their supports. Where utility has disappeared altogether and the suggested outline of a vase, for instance, is used for purely ornamental purpose, supports may be done away with altogether, as appears in these drawings of Italian tapestries of the seventeenth century (Fig. 11).

The stability of pendant objects must also be considered. It is evident that the perpendicular line of suspension must be the line of equilibrium, and that these two must correspond with the design (Fig. 12). Whether any objects should under any circumstances be exposed to the real and apparent danger of falling is a question. We have got so into the habit of hanging pictures, engravings, and other works of art in our houses, and of seeing them hung in galleries, that we have lost sight of the incongruity of the custom. Pictures should be impaneled, and be permanent parts of the walls on which they appear. But, then, how could they be moved when owners tire of them, or tire of their houses, or how could they be gathered together in museums for purposes of study and public enjoyment? Picture frames are of comparatively modern invention. The idea of buying a picture for the purpose of selling it again was not entertained before the fifteenth century. Pictures were as substantial parts of churches and houses as were shrines and fireplaces.

Having very cursively reviewed the elements of form, we are in a position to understand decoration, which is simply the application to form of ornament.

The highest authenticated points at which flowering plants have heretofore been found growing upon the Andes are at about 17,000 feet, although the Kew Herbarium contains several specimens labeled as having been found at altitudes of from 17,000 to 18,000 feet. Sir Martin Conway has brought back from his recent explorations in the Bolivian mountains at least half a dozen species from 18,000 feet and upward, the highest being from about 18,500 feet. They include a saxifrage, a mallow, a valerian, and several *Compositæ*. *Compositæ* likewise attain the upper limit of phanerogamous vegetation in Thibet, where, in latitudes from 30° to 34°, one was found by Dr. Thorold at 19,000 feet.

STEAM TURBINES AND HIGH-SPEED VESSELS.*

By the Hon. CHARLES A. PARSONS, F. R. S.

ALL heat engines at present in use take in heat from a source at a high temperature and discharge most of it at a lower temperature, the disappearance of heat in the process being the equivalent of the work done by the engine. In all cases at the present time the source of heat is from fuel of some kind, and after working the engine the residue is discharged in the case of the steam engine either to the condenser or in the exhaust steam when non-condensing. In the gas engine it is discharged in the waste gases and into the water jacket around the cylinder.

The earliest records of heat engines are found in the Pneumatics of Hero of Alexandria, about 200 B. C. He describes a reaction steam turbine, a spherical vessel mounted on axes supplied with steam through one of the trunnions from a boiler beneath; the steam escaping through two nozzles diametrically opposite to each other and tangential to the sphere, causing the sphere to rotate by the reaction or momentum of the issuing steam, and analogous to a Barker's water wheel.

Thus, the first engine deriving its motive power from fuel was a crude form of steam turbine, and though it could have been applied to useful work, and could easily have been made sufficiently economical to replace manual and horse power in many instances, yet it lay dormant till 1629 A. D., when Bianca suggested the same principle in a different form. Bianca's steam turbine consisted simply of a steam jet fed from a boiler impinging against vanes or paddles attached to the rim of a wheel which was blown round by the momentum of the steam issuing from the jet.

The piston engine is, however, of comparatively modern origin, and dates from about the year 1700 A. D. Engines of this class are so well known that it suffices to say that they have been practically the sole motive-power engines from fuel in use from 1700 up to 1845, and have constituted one of the most important factors in the development of modern engineering enterprise.

Air engines were introduced about the year 1845, and although the larger engines of the Stirling type were very economical in fuel, yet, on account of the inherent difficulty of heating large volumes of air within metal chambers or pipes—a difficulty arising from the low conductibility of air and consequently the overheating and

* Abstract of the Presidential Address to the Institution of Junior Engineers, November 3, 1899.

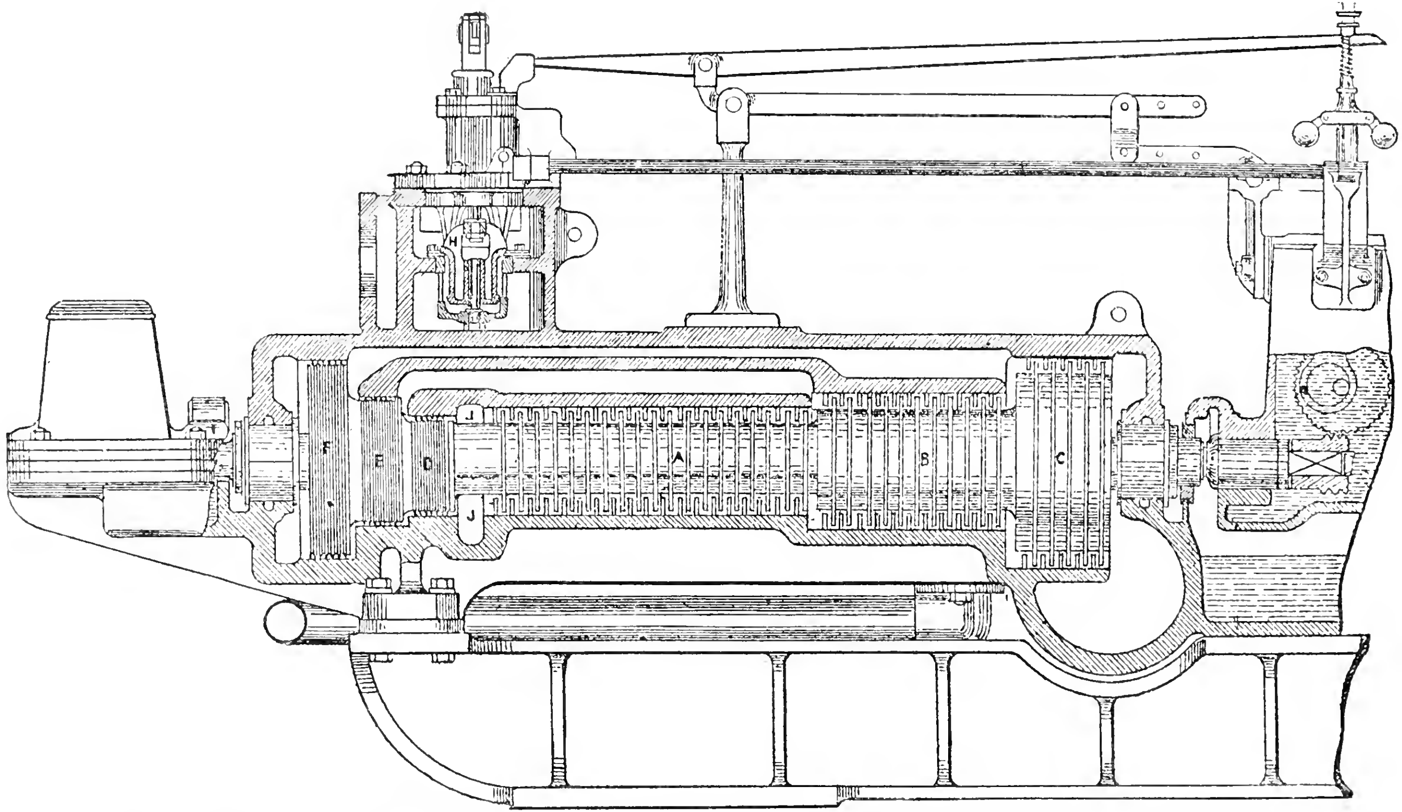


Fig. 1.—Longitudinal Diagram of Parsons's Steam Turbine, with Side of Containing Case removed. The construction of the blades and guide vanes is more clearly shown in Fig. 2. The steam enters at *J* and exhausts after leaving the low-pressure cylinder *C*.

burning of the metal—they have only come into commercial use for very small powers.

During the last thirty-five years gas engines have been perfected, and more recently oil engines, and in point of efficiency both convert a somewhat larger percentage of the heat energy of the fuel into mechanical energy than the best steam engines. All successful oil and gas engines are at present internal-combustion engines, the fuel being burned in a gaseous form inside the working cylinder.

Very numerous attempts have, however, been made to construct internal-combustion engines to burn solid fuel instead of gas. Some have been so far successful as to work with good economy in fuel, but the bar to their commercial success has been the cutting of the cylinder and valves by fine particles of fuel. This difficulty is not present when the fuel is introduced in the gaseous or liquid form, and hence the success of gas and oil engines; but could this difficulty be overcome, the solid fuel would be the cheaper to use.

Internal-combustion engines, gas engines, oil engines, cannon, etc., owe their superior economy in fuel to the very high temperature at which the heat is transferred from the fuel to the working substance of the engine, and consequently the great range of temperature in the working substance of the engine. In steam engines the temperature is limited by the practical difficulties of deterioration of metal and materials involved in the construction.

About fifteen years ago I was led by circumstances to investigate the subject of improving the steam turbine. In recent times several attempts had been made to apply steam turbine wheels of the Hero and Bianca types to the driving of circular saws and fans. The velocity of rotation with either of these types must necessarily be very high in order to obtain a reasonable efficiency from the steam, a velocity much in excess of that suitable for the direct driving of almost all classes of machinery; gearing was considered objectionable, and it therefore appeared desirable to adopt some form of turbine in which the steam should be gradually expanded in small steps or drops in pressure so as to keep the velocity of flow sufficiently low to allow of a comparatively moderate speed of rotation of the turbine engine.

The method adopted was to gather a number of turbines of the parallel flow type on to one shaft and contained in one case, the turbines each consisting of a ring of guide and a ring of moving blades, the successive rings of blades or turbines being graduated in size, those nearer the exhaust end being larger than those near the steam inlet, so as to allow a gradual expansion of the steam during its passage through the turbines.

The form of the turbine was that of a rotating drum, with outwardly projecting rings of blades which nearly touched the containing cylindrical case, and on the case inwardly projecting rings of guide blades which nearly touched the drum. In the first examples of the engine there were two groups of turbines right- and left-handed on each side of the steam inlet, the exhaust taking place at each end of the turbine case, so as to completely balance end pressure from the steam. More recently one series of turbines only has been used, those on the other side of the steam inlet being replaced by packing rings or rotating balance pistons which

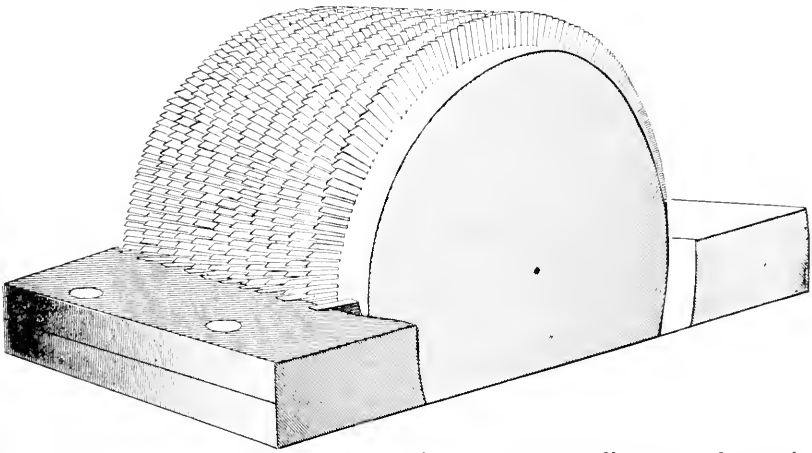


FIG. 2 SHOWS THE ARRANGEMENT OF MOVING BLADES AND GUIDE VANES IN A PARSONS'S TURBINE. The top outer cover has been removed. The cylinder containing the revolving barrel has, as will be seen, a greater internal diameter than the diameter of the drum. It is the annular space thus formed through which the steam flows and which contains the revolving blades and the fixed guide blades. Between each two rings of moving blades there is a ring of guide blades, the latter being keyed into the containing case. The vanes are set at an angle, so that the steam acts on them as wind on the sails of a windmill.

balance the end pressure and divert the whole of the steam through the turbines on the other side.

The steam entering the annular space between the shaft and the case passes firstly through a ring of guide blades attached to the case, and is given a rotational direction of flow; it then passes to the succeeding ring of blades attached to the shaft, by which its direction of rotation is reversed, thereby impressing the difference of its rotational momentum in torque to the shaft. The steam then passes to the second ring of guide blades, and the process is repeated, and so on, gradually expanding by small increments at each ring of blades; the succeeding rings of blades get longer and wider, and at intervals the diameter of the turbine drums, cylinders, and rings are also increased. In condensing turbine engines

of the larger size an expansion ratio in the turbines of one hundred-fold and upward is attained before the steam passes to the exhaust pipe and condenser.

The loss of power present in engines of the piston class, due to cylinder condensation arising from the variation of steam pressure in the cylinder, is not present in the steam turbine, as the steam pressure remains constant at each turbine ring and each part of the cylinder and barrel, and the numerous tests of steam consumption that have been made have shown that compound steam turbine engines of moderate sizes when working with a condenser are comparable in steam consumption per effective horse power with the best compound or triple condensing steam engines of the piston type. They have been constructed in sizes up to about one thousand horse power for driving alternators and dynamos, and several sets of about two thousand horse power are nearing completion.

The application of the compound steam turbine to the propulsion of vessels is a subject of considerable general interest, in view of the possible and probable general adoption of this class of engine in fast vessels.

In the turbine is found an engine of extremely light weight, with a perfectly uniform turning moment, and very economical in steam in proportion to the power developed, and, further, it can be perfectly balanced so that no perceptible vibration is imparted to the ship. The problem of proportioning the engine to the screw propellers and to the ship to be driven has been the subject of costly experiments extending over several years, with the result that a satisfactory solution has been found, giving very economical results in regard to pounds of steam consumed in the engines per effective horse power developed in propelling the vessel, results which are equal or superior to those so far obtained with triple-expansion engines of ordinary type in torpedo boats or torpedo-boat destroyers. The arrangement adopted may be best described by saying that instead of placing, as usual, one engine to drive one screw shaft, the turbine engine is divided into two, three, or sometimes more separate turbines, each driving a separate screw shaft, the steam passing successively through these turbines; thus when there are three turbines driving three shafts, the steam from the boiler passes through the high-pressure turbine, thence through the intermediate, and lastly through the low, and thence to the condenser.

As to the propellers, these approach closely to the usual form. It has, however, been found best to place two propellers of approximately the same pitch on each shaft at some considerable distance apart, so that the after one shall not be seriously affected by the

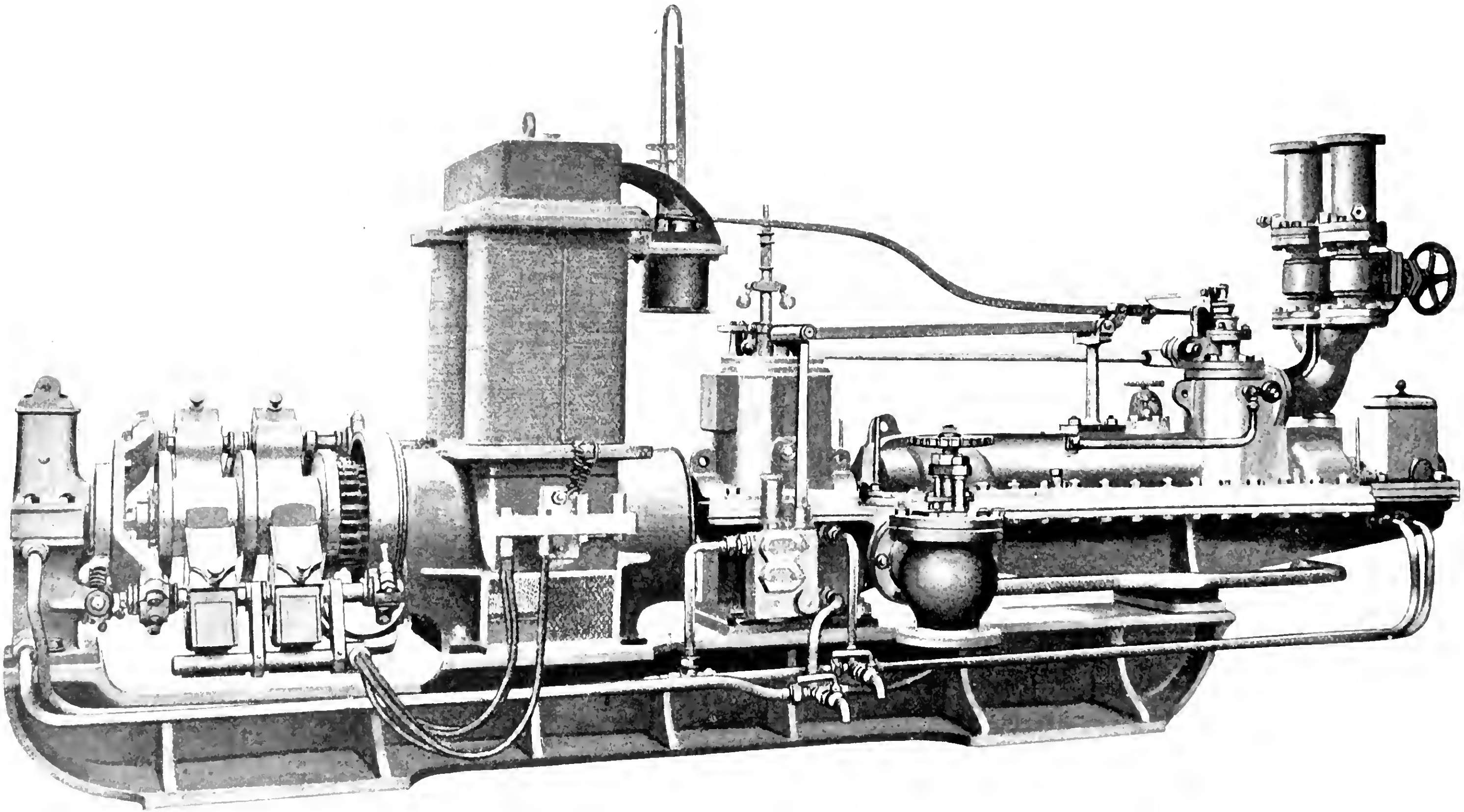


Fig. 3.—A Seventy-five Kilowatt Turbine Engine directly connected to a Dynamo. The turbine engine is on the right.

wash of the one in front. The advantage of this arrangement is that a sufficient blade area is obtained to carry the thrust necessary to drive the vessel with a lesser diameter of propeller, and so permitting of a higher speed of revolution of the engines.

The problem was complicated by the question of cavitation, which, though previously anticipated, was first practically found to exist by Mr. Thornycroft and Mr. Barnaby in 1894, and by them it was experimentally determined that cavitation, or the hollowing out of the water into vacuous spaces and vortices by the blades of the propeller, commences to take place when the mean thrust pressure on the projected area of the blades exceeds eleven pounds and a quarter per square inch. This limit has since been corroborated during the trials of the Turbinia.

This phenomenon has also been further investigated in the case of model propellers working in an oval tank of water, and to permit of cavitation at more moderate speeds than would otherwise have been necessary, the following arrangement was adopted: The tank was closed, plate-glass windows being provided on each side, through which the propeller could be observed, and the atmospheric pressure was removed from the surface of the water by an air pump; under this condition the only forces tending to prevent cavitation were the small head of water above the propeller, and capillary attraction.

In the case of a propeller of two inches in diameter, cavitation commenced at about twelve hundred revolutions, and became very pronounced at fifteen hundred. Had the atmospheric pressure not been removed, speeds of twelve thousand and fifteen thousand respectively would have been necessary.

Photographs were taken with a camera made for the purpose, with a focal plane shutter giving an exposure of about one thousandth of a second, the illumination being by sunlight concentrated on the propeller from a twenty-four-inch concave mirror.

Photographs were also taken by intermittent illumination of the propeller from an arc lamp, the arrangement consisting of an ordinary lantern condenser, which projected the beam on to a small concave mirror, mounted on a prolongation of the propeller shaft, the reflected beam being caught by a small stationary concave mirror at a definite position in each revolution and reflected on to the propeller. By this means the propeller was illuminated in a definite position at each revolution, and to the eye it appeared as stationary. The cavities about the blades could also be clearly seen and traced, the photographs being taken with an ordinary camera and about ten seconds' exposure.

A series of experiments was also made with model propellers in

water at and just below the boiling point, dynamometric measurements being taken of power and thrust with various widths of propeller blade, the conclusion arrived at being that wide and thin blades are essential for fast speeds at sea, as well as a coarse pitch ratio of propeller.

The first vessel fitted with steam turbine machinery was the Turbinia. She was commenced in 1894, and, after many alterations and preliminary trials, was satisfactorily completed in the spring of 1897. Her principal features are: Length, one hundred feet; beam, nine feet; five-foot draught of water under the propellers; forty-four tons and a half displacement on trial; she is fitted with a water-tube boiler of eleven hundred feet total heating surface, and forty-two square feet of grate area, with closed stokeholds supplied with air from a centrifugal fan mounted on a prolongation of the low-pressure turbine shaft. The engines consist of three compound steam turbines, high pressure, intermediate, and low pressure, each driving one screw shaft; on each of the shafts are three propellers, making nine in all; the condenser is of the usual type, and has four thousand square feet of surface.

When officially tested by Professor Ewing, F. R. S., assisted by Professor Dunkerley, she attained a mean speed on a measured mile of thirty-two knots and three quarters, and the consumption of steam for all purposes was computed to be fourteen pounds and a half per indicated horse power of the main engines. Subsequently, after some small alterations to the steam pipe, she was further pressed, and is estimated to have reached the speed of thirty-four knots and a half. She was, and still is, therefore, the fastest vessel afloat; she has been out in very rough weather, is an excellent sea boat, and at all speeds there is an almost complete absence of vibration.

In the Turbinia the exceptional speed results principally from two causes: 1. The engines, screws, and shafting are exceptionally light. 2. The economy of steam in the main engines is greater than usual.

At full speed the steam pressure in the boiler is two hundred and ten pounds; at the engines, one hundred and seventy-five; and the vacuum in the condenser twenty-seven inches, representing an expansion ratio in the turbines of about one hundred and ten after allowance has been made for wire-drawing in the exhaust pipe.

The first vessels of larger size than the Turbinia to be fitted with steam turbine machinery are the torpedo-boat destroyer Viper for the British Government, and a similar vessel for Messrs. Sir W. G. Armstrong, Whitworth & Company.

These vessels are of approximately the same dimensions as the

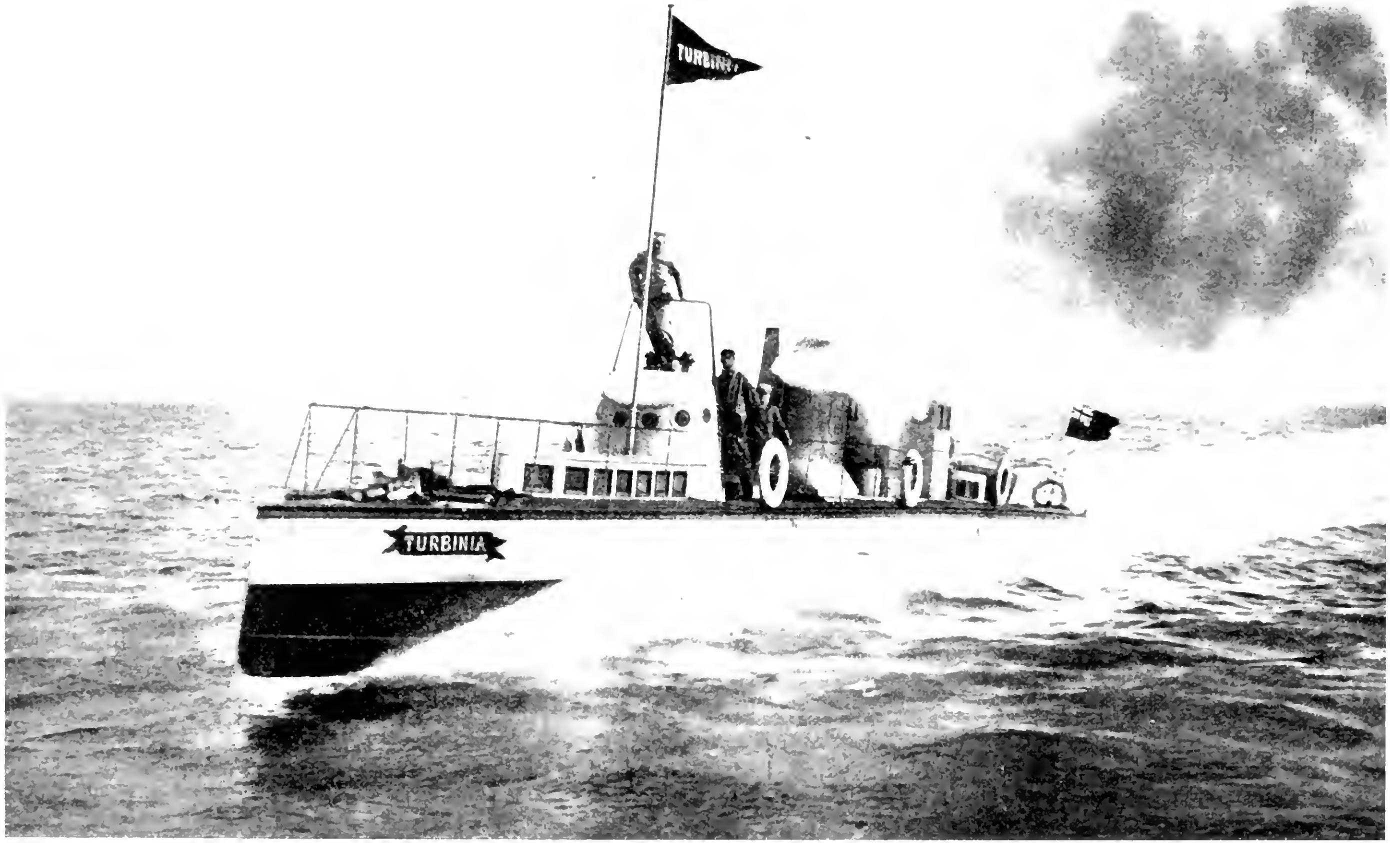


Fig. 4.—The Turbinia running about Forty Miles an Hour.

thirty-knot destroyers now in her Majesty's service, but have slightly more displacement. The boilers are about twelve per cent larger, and it is estimated that upward of ten thousand horse power will be realized under the usual conditions, as against sixty-five hundred with reciprocating engines.

The engines of these vessels are in duplicate. Two screw shafts are placed on each side of the vessel, driven respectively by a high- and a low-pressure turbine; to each of the low-pressure turbine shafts a small reversing turbine is permanently coupled for going astern, the estimated speed astern being fifteen knots and a half, and ahead thirty-five knots; two propellers are placed on each shaft.*

The latter of these two vessels has commenced her preliminary trials, and has already reached a speed of thirty-two knots. The manipulation of the engines is a comparatively simple matter, as to reverse it is only necessary to close one valve and open another, and, owing to there being no dead centers, small graduations of speed can be easily made.

In regard to the general application of turbine machinery to large ships, the conditions appear to be more favorable in the case of the faster class of vessels such as cross-Channel boats, faster passenger vessels, cruisers, and liners; in such vessels the reduction in weight of machinery, as well as economy in the consumption of coal per horse power, are important factors in the case, and in some vessels the absence of vibration, both as regards the comfort of passengers, and in the case of ships of war permitting greater accuracy in sighting of the guns, is a question of first importance.

As regards cross-Channel boats, the turbine system presents advantages in speed, absence of vibration, and, owing to the smaller diameter of the propellers, reduced draught.

As an instance, a boat of two hundred and seventy feet length, thirty-three feet beam, one thousand tons displacement, and eight feet six inches draught of water could be constructed with spacious accommodation for six hundred passengers, and with machinery developing eighteen thousand horse power; she will have a sea speed of about thirty knots, as compared with the speed of nineteen to twenty-two knots of the present vessels of similar size and accommodation.

It is, perhaps, interesting to examine the possibilities of speed that might be attained in a special unarmored cruiser, a magnified torpedo-boat destroyer of light build, with scanty accommodation

* On her second trial trip the Viper attained a mean speed of 34.8 knots, her fastest trial being over 35 knots, or about 41 statute miles per hour, with an indicated horse power of 11,000. This vessel is of about 350 tons displacement.

for her large crew, but equipped with an armament of light guns and torpedoes. Let us assume that her dimensions are about double those of the thirty-knot destroyers, with plates of double the thickness and specially strengthened to correspond with the increased size—length, four hundred and twenty feet; beam, forty-two feet; maximum draught, fourteen feet; displacement, twenty-eight hundred tons; indicated horse power, eighty thousand; there would be two tiers of water-tube boilers; these, with the engine space, coal bunkers, etc., would occupy the whole of the lower portion of the vessel; the crew's quarters and guns would be on the upper decks. There would be eight propellers of nine feet in diameter revolving at about four hundred revolutions per minute, and her speed would be about forty-four knots.

She could carry coal at this speed for about eight hours, but she would be able to steam at from ten to fourteen knots with a small section of the boilers more economically than other vessels of ordinary type and power, and, when required, all the boilers could be used, and full power exerted in about half an hour.

In the case of an Atlantic liner or a cruiser of large size, turbine engines would appear to present some considerable advantages. In the first place they would effect a reduction in weight of machinery and some increase in economy of fuel per horse power developed, both thus tending either to a saving in coal on the one hand, or, if preferred, some increase in speed.

The advantages are, however, less pronounced in this class of vessel on account of the smaller relative power of the machinery and the large quantity of coal necessary for long voyages, but the complete absence of vibration at all speeds, not to mention many minor considerations of saving in cost and reduced engine-room staff, are questions of considerable importance.

A SURVIVAL OF MEDIÆVAL CREDULITY.

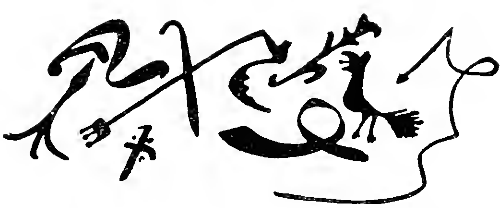
By Professor E. P. EVANS.

[*Concluded.*]

IN the seventeenth year of her age Miss Diana Vaughan joined the Freemasons, entering the lodge ("triangle") of "The Eleven Seven," at Louisville, and passing rapidly through the different grades until the "Elect Palladistic Knighthood" was conferred upon her after she had given satisfactory proofs of her Luciferian orthodoxy. One thing she refused to do—namely, to stab the host with a dagger—since this act implied a recognition of the sacramental character of the Eucharist. She maintained that there

would be no sense in piercing the consecrated wafer unless it was believed to be the real body of Christ; but as she rejected the doctrine of transubstantiation as a childish superstition, she was unwilling to make a fool of herself by assaulting a piece of ordinary bread with a show of wrath. She would not hesitate to commit sacrilege, but did object to being silly. This scruple, or rather this lively sense of the ridiculous, rendered her unpopular with the Freemasons, inasmuch as it marred the performance of their most important and impressive Satanic ceremony, and thus gave her rival, Sophia Walder, an advantage, which she was quick to improve.

We need not follow the career of Sophia Walder, known to the infernals as Sophia Sapho. She is said to have been born in Strasburg, September 29, 1863, as the supposititious daughter of a Protestant parson, Philias Walder, and a Rosicrucian dame, Ida Jacobsen, with whom the clergyman lived after having murdered his wife in Copenhagen. Her real father, however, was the devil Bitru, who declared her to be the predestined great-grandmother of antichrist. In 1896, while in Jerusalem, she gave birth to a daughter, the grandmother of antichrist; this child was also of demoniac paternity. Owing to her uncompromising Luciferianism, she was a favorite of the Freemasons, and excited the jealousy of Diana Vaughan, who tells with zest of the practical jokes played on her. Thus, at a banquet of the Freemasons, somebody put a few drops of Lourdes water in her glass of lemonade, which caused terrible pain and threw her into spasms, from which she finally found relief by vomiting fire. This incident is cited by a Catholic writer, Dr. Michael Germanus,* in his Secrets of Hell (*Geheimnisse der Hölle*), as conclusive proof that "Sophia was possessed."



Bitru's proclamation of Sophia Sapho as the prospective great-grandmother of the incarnate antichrist is given in full. It was dictated in Latin by Bitru at a meeting of Freemasons in Italy, and written down by Luigi Revello, and bears the devil's signature, composed of Satanic signs and symbols, darts, sword, cords, lightning, bugle-horn, trident, and crowing cock.

* Michael Germanus (a Latinization of "*Der deutsche Michel*," the personification of the German nation, analogous to the English "John Bull" and the American "Brother Jonathan") is the pseudonym of a priest, Parson Künzle, of Feldkirch, in the Tyrolese Voralberg.

This climax of absurdity ought to have served to expose the trickery and trumpery of the whole affair, but it produced the very opposite effect. Dr. Germanus refers to "Bitru's sign-manual as highly interesting," and characterizes "the documentary evidence as thoroughly convincing"; those who refuse to recognize the truth in the face of such positive proof he accuses of imitating the ostrich and willfully shutting their eyes to the light.*

The salvation of Diana Vaughan is described as due to her intense admiration for Joan of Arc, a feeling which was ardently fostered by the priests with whom she chanced to come in contact. One day, as she was attended by Asmodeus, Astaroth, Beelzebub, and Moloch, incarnate in "the counterfeit presentment" of fine gentlemen, she obeyed a sudden and irresistible impulse to invoke the Maid of Orleans, when these devils were immediately stripped of their disguise, and stood before her in their true character as imps of hell, with hoofs and horns, and emitted an intolerable stench. No sooner did they perceive that they were unmasked than they vanished with a fearful howl. This miracle made a deep impression upon her, and led to her conversion. She took refuge in a Parisian cloister, and, after severe penance and proper instruction, was received into the bosom of the Catholic Church. During this period of penitential seclusion she wrote her Memoirs, which produced an immense sensation in clerical circles, and were pronounced by a high ecclesiastical dignitary to be "worth more than their weight in gold."

It must be confessed that in weaving this tissue of fabrications Taxil showed consummate skill as a romancer and a profound knowledge of the possibilities of human credulity. He made a happy hit in calling the heroine of his Stygian story Diana, since in the annals of witchcraft the pagan goddess of the chase is wont to frequent the nocturnal assemblies of demons, and in mediæval theology the phrase "*congressus Sabathi cum Diana*" was a common expression for intercourse with Satan. Another masterly stroke was to represent her deliverance from the snares of evil spirits and the hallucinations of Luciferianism as a miracle of grace wrought through the mediation of Joan of Arc, thus furnishing an argument in favor of the canonization of the Maid of Orleans, which the cleverest *advocatus diaboli* would be unable to answer. At this time Taxil prepared also a Catholic prayer book entitled

* A photographic reproduction of this document is given in Diana Vaughan's biography of the Italian statesman Crispi, which contains numerous illustrations and portraits of Crispi, Mazzini, Lemmi, Garibaldi, Giordano Bruno, and other "Palladists," or Masonic worshipers of Satan. The original French title of the book is "Le 33e ∴ Crispi. Un Palladiste Homme d'Etat démasqué. Biographie documentée du Héros depuis sa Naissance jusqu' à sa deuxième Mort. Par Miss Diana Vaughan."

Eucharistic Novena, published under the name of Diana Vaughan, and containing forms of supplication against unbelief, worldly indifference and lukewarmness, hardness of heart, blasphemy, and unchastity. The covert sarcasm which pervades the entire manual of devotion comes out most clearly in the section on the violation of the seventh commandment. A copy of the work, which had been approved by the Archbishop of Genoa, was sent to Cardinal Parocchi, with a letter signed "Your Eminence's most devoted servant in Jesus, Mary, and Joseph, Diana Vaughan," and five hundred francs, of which two hundred and fifty were to be used for organizing an international antimasonic congress, and the rest to be given as Peter's pence to the Pope. The cardinal replied with great cordiality to his "dear daughter in our Lord," called her conversion "one of the most glorious triumphs of grace," and added, "I am reading at this very moment your Memoirs with burning interest." He gave her his blessing, and conveyed "the thanks and special benediction of his Holiness." Numerous letters of a like character were received from the Vatican. On May 27, 1896, the General Secretary of the Apostolic See, Verzichi, wrote that "his Holiness had read her *Eucharistic Novena* with extreme pleasure"; two months later the Pope's private secretary, Vincenzo Sardi, thanked her in the name of Leo XIII for her exposure of Crispi, and bade her "continue to write and to unmask the godless sect," and the *Civiltà Cattolica*, the official organ of the papacy, praised her "inexhaustibleness in precious revelations, which are unparalleled for their accuracy and usefulness. Freemasonry is confounded, and seeks to evade the blows of the valiant championess by denying her existence, and treating her as a myth. It is a pitiable shift, but Freemasonry can find no better refuge." "Your pen and your piety," wrote Monsignore Villard, October 15, 1896, "are predestined to demolish the foes of mankind. The good works of the saints have always met with opposition, and it is no wonder, therefore, that yours should be combated."

Naturally, there was intense curiosity to see this new convert and powerful defender of the faith. This inquisitiveness was easily allayed at first by the plea that the cloister to which she had retired must be kept secret, in order that she might be safe from assassination by the Freemasons. Meanwhile the medium of correspondence was a bright American girl, employed as copyist in a Parisian typewriting establishment, who wrote all the letters at Taxil's dictation, and received a monthly salary of one hundred and fifty francs for her services. After a time he deemed it politic to introduce her privately to select circles of Catholics, who were thereby enabled to testify to her existence, since they had seen and con-

versed with her. The following incident may be mentioned to illustrate the adroitness with which she played her part: M. Pierre Lautier states that he once breakfasted with her, and offered to pour a little Chartreuse into her coffee, but she refused it with a singular sign of aversion, and took a few drops of old cognac instead. As an ex-Luciferian, she instinctively shrank from a drink made in a cloister, or what she called "an Adonaïc liquor." That she should have thought of such a feint on the spur of the moment indicates that she had not only made a thorough study of her rôle, but also had been endowed by Nature with genuine theatrical talent. A full account of the solemn sham, published in the *Revue Mensuelle*, served to strengthen the faith of waverers in the reality of Diana Vaughan, and furnished an admirable opportunity for discoursing on the difficulty of throwing off Satanic influences; for here was a young lady who, although she had received absolution and thus become a child of grace, could not forget the terrible effect of a few drops of Lourdes water on one of her former demonolatrous associates, and recoiled with horror from a glass of Chartreuse. Taxil and his confederates confess that they often "doubled up with laughter" over the success of their imposture, and indulged in jokes about it in their writings. Thus Dr. Bataille, in the first volume of The Devil in the Nineteenth Century, remarks, as a peculiarity of Diana Vaughan, that she "is very fond of wearing male attire," but no allusions of this kind, however pointed, seemed to have excited any suspicion of guile in minds predisposed to credulity by Nature and by education.

Taxil's long series of mystifications, extending over a dozen years, culminated in the convocation of an antimasonic congress at Trent, on September 26, 1896, to the president of which Leo XIII addressed an apostolical brief with his benediction, and expressed the hope that the assembled representatives of the Church would not rest until the "detestable sect" had been unmasked and the evil utterly eradicated. A "central executive committee," consisting of a score of Italian papists, issued a circular summoning all Catholics to join "the new crusade," and declaring that the Vatican had now raised a war-cry against Freemasonry, "the den of Satan," as it did eight centuries ago against Islam. Taxil was received with ovations, and did not hesitate to poke fun at the venerable prelates to their very faces. With an assumption of modesty he reproved them for what might be misplaced enthusiasm. "One can never be sure," he said, "of a converted Freemason, but must always fear lest he may return to his former friends. Not until the convert is dead can one be wholly free from this anxiety. I am well aware that this general principle applies

also to myself." But even this daring dash of irony, hardly hidden under the gauzy disguise of self-distrust, did not cool the ardor of his admirers, who continued to greet the harlequin with "*Evviva Taxil!*" His photograph hung among the pictures of the saints, and the mere mention of his name called forth loud applause, whereupon the prince of mountebanks rose and bowed. A few Germans had the good sense and courage to protest against these demonstrations, and to doubt the existence of Diana Vaughan and the sincerity of Taxil, whose sole object, as Dr. Gratzfeld asserted, was to "lay a snare for Catholics and anti-Freemasons, and scoff at them when they are caught in it." This skepticism created intense excitement, and was severely rebuked by an Italian priest and a Parisian prebendary, who averred that they knew Diana Vaughan personally, and could vouch for her saintliness. A French monk used such violent language in his reply to Dr. Grätzfeld that the presiding officer, although indorsing his views, felt constrained to call him to order. "Any doubt of Diana Vaughan's existence or of the genuineness of her revelations," exclaimed the Abbé de Bessonies, "is a sin against the antimasonic cause!" The Spanish delegates introduced a resolution demanding that all Freemasons should be legally incapacitated to hold any civil office or military command; the resolution was adopted, with the amendment that "wherever it may be feasible" such laws should be enacted and executed. The manner in which Taxil met the allegations of his opponents is highly characteristic. "A priest of the Holy Sacrament, Father Delaporte, had often declared that he would gladly give his life for the conversion of Diana Vaughan. She attended mass in the cloister for the first time on Corpus Christi, and left her sacred retreat on the following Saturday. On the very day of her departure Father Delaporte died. And yet there are persons who doubt the existence of Miss Vaughan!" The burst of applause elicited by this irrefragable argument proved his accurate appreciation of the logical powers of his auditors, whose minds had been fed on the nutriment which may be wholesome as "milk for babes," but, when persistently administered to adults, converts them into intellectual milksops.

Although the congress was attended by many of the chief dignitaries of the papal hierarchy, and the Romish Patriarch of Constantinople sat there in state with a golden crown on his head, Taxil was its ruling spirit. On his motion, it was resolved to establish antimasonic associations in every land under the auspices of the bishops and the direction of national committees, and a commission was appointed to investigate the Diana Vaughan affair. A few months later, on January 22, 1897, this commission made

an indecisive and utterly nugatory report, to the effect that "no thoroughly convincing evidence had been furnished for or against the existence and conversion of Diana Vaughan and the authenticity of the writings attributed to her." This evasion of the issue, however, did not shake the confidence of the ultramontane press, nor prevent its positive affirmation of the points which the commission had discreetly left in doubt. As a reward for this fanatical zeal and steadfast credulity, the editor of The Pelican received a special apostolical benediction, and was thus encouraged to "resist the raging of Satan." "Stand firm!" he exclaimed. "The Holy Father is with us, and who is over him?"

With the Congress of Trent the mystification which Taxil had been playing off on papacy for so many years had reached the acme of success, and nothing now remained but to wind up the plot with a drastic *dénouement*. Accordingly, Diana Vaughan issued an invitation to a conference to be held on April 19, 1897, in the great hall of the Geographical Society of Paris. It was also stated that other conferences would be held in the principal cities of France, Italy, England, and the United States. The programme for the evening was quite elaborate, beginning with a lottery for an American typewriter and ending with a series of fifty-four stereopticon pictures representing, among other fantastic scenes, Sophia Walder and her serpents, events in the life of Diana Vaughan, the apparition of the devil Bitru in Rome, Eden and Eve with the fatal apple, sacrilegious stabbing of the host on a Satanic altar in a Masonic lodge at Berlin, and finally Leo XIII with the encyclical letter *Humanum genus* as a flaming sword in his hand, the archangel Michael on his right and the apocalyptic St. John on his left treading the triple-headed dragon of Freemasonry under foot. The audience consisted chiefly of priests, with a few Protestant clergymen and Freemasons, and an unusually large number of newspaper reporters. The typewriter was won by Ali Kemal, correspondent of the Constantinople journal *Ikdam*, who only regretted that it did not write Turkish. Taxil then appeared on the platform, and began his address with the words: "Reverend sirs, ladies, and gentlemen! You wish to see Diana Vaughan. Look at me! I myself am that lady!" After this startling exordium, he proceeded to relate how from his youth up he had always had an irresistible inclination to play practical jokes. Once he frightened the inhabitants of Marseilles by discovering a shoal of sharks in the harbor, and again he set the archæologists all agog by announcing the existence of a city, built on piles, at the bottom of Lake Leman. But these were "childish things" compared with the manner in which he had humbugged the Catholic clergy for nearly a dozen

years. We need not report the details of his discourse; it is sufficient to say that he gave a full account of the deep-laid plot from its first conception to its final consummation at the Congress of Trent. Each new disclosure called forth cries of "Liar!" "Scoundrel!" "Vilifier!" "Villain!" and similar epithets, but nothing could disturb the cynical composure of the speaker. As a precautionary measure, all persons had been required to give up their canes and umbrellas at the entrance, otherwise the angry words would have been emphasized by blows. The shameless impostor coolly referred to the numerous presents received, among which was an Emmenthaler cheese, sent by the Marquis de Morès, with pious sayings carved in the rind. "It was an excellent cheese," he added, "and served to strengthen me in my fight against Freemasonry." The money remitted to Diana Vaughan in ten years amounted to more than half a million francs, and flowed into the pockets of Taxil and his confederates. He expressed his thanks to the clergy for their aid in carrying out his scheme, and attributed their cooperation chiefly to ignorance and imbecility, but partly also to dishonesty, declaring that among the many dupes there were not a few knaves. As he left the hall he was threatened with violence, and took refuge in a neighboring *café*, under the protection of the police. No one thought any longer of the pictures which were to form such a novel and attractive feature of the entertainment; indeed, this forgetfulness constituted an important although unprinted part of the programme in the minds of those who arranged it.

How difficult it is for constitutionally credulous persons, in whom this disposition has been nurtured by education, to take a rational view of things when a strong appeal is made to their prejudices, is evident from a statement published in the *Osservatore Cattolico* of Milan, in May, 1897, that Leo Taxil was held in durance vile by the Freemasons, one of whom personated him on the occasion just described. Another Catholic writer asserted that Diana Vaughan did not appear at the conference because Taxil had been bribed by the Freemasons to have her shut up in a lunatic asylum.

The history of Taxil's imposture has been circumstantially narrated in a book entitled *Leo XIII und der Satanskult*, by Dr. J. Ricks (Berlin: Hermann Walther, 1897, pp. xiv–301; price, three marks). The author, a doctor of divinity and pastor of a Lutheran church at Olvenstadt, near Magdeburg, has collected his materials from authentic sources and treated the whole subject with remarkable thoroughness and impartiality. His work is a valuable contribution to the voluminous annals of religious superstition and credulity.

The ease with which Taxil succeeded in duping so many prominent representatives of the papal hierarchy naturally disturbed the equanimity of the most intelligent Catholics, especially in Germany, and caused them to sound a note of alarm. How is it possible, they asked themselves, for a large body of educated men, claiming to be the spiritual guides of the people, to become the victims of so plump an imposition? Is it not due to radical defects in the development and discipline of the intellectual faculties? Nearly a century ago Madame de Staël remarked that "since the Reformation the Protestant universities stand unquestionably higher than the Catholic, and the whole literary fame of Germany emanates from these institutions"; and this opinion has been quoted and indorsed by the unimpeachable authority of an eminent Catholic theologian, the late Professor Döllinger.* Recently another Catholic, Dr. Hermann Schell, Professor of Apologetics in the University of Würzburg, has called attention to the latest statistics of religious denominations in Germany, showing the inferiority of Catholics, as indicated by their comparative lack of interest in higher education and the smaller percentage of them in the learned professions.† In this connection he refers to Taxil's successful exposure of the intellectual deficiencies, which render the hierophants of Roman Catholicism incapable of resisting the most palpable delusions of superstition. His two "tracts for the times," as they might fitly be termed, *Der Katholicismus als Princip des Fortschritts* and *Die neue Zeit und der alte Glaube*, maintain that Catholicism should be progressive, and that the old faith can remain a living force in each new era only by adapting itself to every real advance of mankind in knowledge and thus becoming reanimated by the spirit of the age. Professor Schell expresses his sympathy

* *Cf.* Ignaz von Döllinger. Sein Leben auf Grund seines schriftlichen Nachlasses dargestellt von J. Friedrich. München: Beck, 1899, vol. i, p. 77.

† In confirmation of this statement we may cite the statistical tables of Dr. Von Mayr for 1896, giving the number in every ten thousand of the different denominations attending the gymnasia or classical schools, the scientific schools with Latin, and the scientific schools without Latin:

Protestants	27.7	13.2	12.5
Catholics	21.1	3.8	6.7
Dissidents	17.7	13.2	18.7
Jews	173.7	65.8	92.7

The Catholic students in the gymnasia are mostly candidates for the priesthood. "Dissidents" are members of free religious associations. A noteworthy feature is the large proportion of Jews, and curiously enough this laudable characteristic is made by anti-Semitic agitators a ground of crimination and used to prejudice the public mind. Not long since a demagogue of that ilk in Berlin charged the Jews with putting forth every effort for the education of their sons, in order that they might more effectually compete with Christians; "therefore down with the Jews!"

with the movement in favor of greater freedom of thought and independence of research, known as "Americanism" in the Catholic Church, and regards its extension to the Old World as a vital necessity.*

It is creditable to the Catholic prelates in the United States that they were not among the foolish birds caught with the lime laid by Leo Taxil. Indeed, the Bishop of Charleston went to Rome for the express purpose of warning Leo XIII against this trickster, but was sharply reprehended and admonished to be silent. A similar rebuke was given to the Apostolic Vicar of Gibraltar for denying the existence there of Tubal-Cain's subterranean laboratory for manufacturing microbes.

The *Breviarium Romanum*, the daily use of which, as a manual of devotion and edification, is enjoined by the Pope on the clergy, is full of legends which are recorded as historical facts, and quite equal in absurdity to Taxil's most extravagant and fantastic inventions. The tales there told of the miracles wrought by saints, their communion with angels, and their combats with devils may have easily suggested many incidents narrated in The Devil in the Nineteenth Century and the Memoirs of Diana Vaughan. It is no wonder that minds accustomed to accept the marvels of hagiology as actual events should be readily deceived by a clever caricature of them, especially when appealing to a prejudice so absurd and yet so strong as that entertained by the papacy against Freemasonry. It would seem from many indications that the Romish Church, as an ecclesiastical organization, bears about the same relation to contemporary culture that Roman paganism did to the best thought of the period when Lucian wrote his sprightly dialogues and Lucretius his genial and comprehensive didactic poem *De Rerum Natura*. Is it doomed to the same fate, or has it, as Professor Schell and Dr. Müller assert, a saving, recuperative power?

Of the geological age of the building stones used in the United States, George P. Merrill observes, in his report to the Maryland Geological Survey, that few stones are used to any extent that are of later date than the Triassic, and few, if any, of our marbles are younger than the Silurian, while nearly all our granites, as now quarried, belong at least to Palæozoic or Archæan times. Stones of later age than Triassic are, so far as relates to the eastern United States, so friable or so poor in color as to have little value.

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* Since these lines were written Professor Schell has been disciplined and threatened with excommunication by the See of Rome. We regret to be obliged to add that he did not have the courage to maintain his opinions, but made a public recantation of them. The cause of progress in the Catholic Church has now found a new and apparently more fearless advocate in a Bavarian priest, Dr. Müller, of Munich, whose pamphlet on Reformkatholizismus can hardly escape the interdict of the papal hierarchy.

GENUINE STARCH FACTORIES.

By BYRON D. HALSTED, Sc. D.,
RUTGERS COLLEGE.

MUCH in this world is neither upon first nor last analysis true to name. From the corner grocery we buy a pound of starch in a rectangular package highly decorated with lithograph and lettering, setting forth the excellences of the product, "superior to all others," and manufactured, with the utmost care, by Messrs. So-and-So. The fact is that the big seven-story establishment did not make a grain of the starch, and the best that can be claimed is a satisfactory method of bringing the product already formed into the present acceptable condition.

But it is not the purpose of this paper to decry the refineries, whether they be of starch, sugar, or this or that of a hundred natural products, but to direct attention to the source of that very common and, it may be safely said, indispensable substance known to the English-speaking people as starch.

It will be no new surprise to state, by way of introduction to the subject, that starch is the ordinary everyday product of ordinary everyday plants. So humble a vegetable as the potato has gained its way into all lands of the more civilized peoples almost solely because it has a habit of storing away, in large underground stems, a vast amount of starch. Let this provident tendency disappear in this plant for a single season, and the crop growers would discard it from their list of remunerative plants, while millions of people would turn with dismay to some other source of a daily supply of starch. What this change in the nature of a single kind of plant would mean to the human race words can not describe. If the famine in Ireland of 1845 and some later years, induced by a rot in the potato, is any index, the misery would be

FIG. 1.—STARCH GRANULES OF THE POTATO.

something worse than we should care to even dream of. When there is a shortage of starch in India, a distress follows that is felt through the bonds of sympathy, if in no other way, the whole world round. Let rice fail to mature its grain, which means, in short, not to store its starch in available form for man, and the dependent race is brought to the ghostly condition of starvation and thrown upon the charity of those people whose starch is in their grain elevators, sacks, and barrels almost without number.

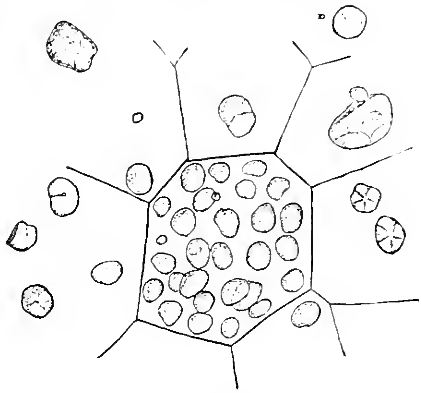

Fig. 2.—Starch Granules of Corn.

Starch, it would seem from this, is the prime food element of the human family, the chief factor in the upbuilding of a race, because a fundamental aliment of our bodies.

If the starch factories do not make, in the true sense, the product of their mills, it may be to the point to consider how this all-important substance comes into existence. The organic chemist tells us that starch is a ternary compound, and this agrees closely with the definition laid down by the dictionaries, only they add that it is odorless, tasteless, and insoluble in water. It is one of the proximate principles of plants, and is stored in the form of granules wonderfully variable in size and shape, but each kind having a type that is adhered to with much regularity. For example, the ordinary potato (*Solanum tuberosum* L.) produces a starch granule that is characterized by a form resembling the shell of the oyster. Fig. 1 is from a camera drawing of a cell from the center of a potato, with portions of adjoining cells, all of which were packed full of starch, a few grains only being represented.

Starch is acted upon differently by reagents, one of the leading tests for it being a solution of iodine. A drop of a very weak solution will determine the presence of starch in a cuff or shirt front by leaving a blue spot or streak where the iodine has been applied. By means of this reagent the student of plant tissues is readily able to locate starch when present in any slice of tissue he may have made. He would, for example, find much more starch in the tuber of the potato than in any other portion of the plant, and there the grains will be found many times larger than in the stem or the cells of the green leaves. Of the relation of the starch in

the leaves to that in the underground stem something may be said later in this paper.

In the corn plant the starch is stored chiefly in the grain, and not in the subterranean portions, as in the potato. The granules of the corn starch are much smaller than those of the potato, as indicated by Fig. 2, which is from a camera drawing of a cell from a grain of corn and made to the same scale as Fig. 1. The granules are oval and not much marked with striæ or lines, but chemically the substance is the same in both cases.

Another leading starch is that of wheat, the form of the grains of which is shown in Fig. 3. While somewhat larger than the corn-starch granules, they are not otherwise widely different.

One could scarcely overlook the starch produced by the rice plant, for it feeds more people than the potato, corn, or wheat. The relative size and form of the rice-starch granules are shown in

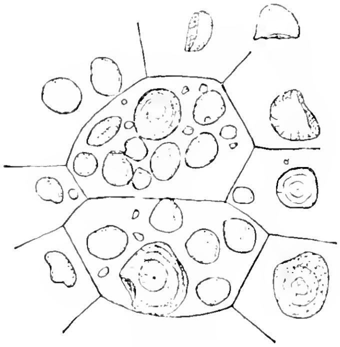

FIG. 3.—STARCH GRANULES OF WHEAT.

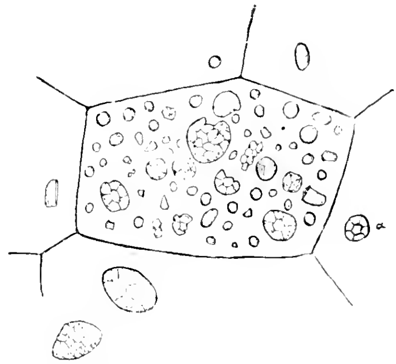

FIG. 4.—STARCH GRANULES OF RICE.

Fig. 4. It is seen that the grains are not large, and with a strong tendency to break up into small angular pieces.

There are almost as many forms of starch as plants producing it, some of them being very odd in shape. Thus the tapioca starch has a characteristic form, as also the sago; but it is not the purpose here to more than call attention to the form in which the substance under consideration is laid down in plants. The student of food adulterations is an expert in the detection of starches, and, with his microscope and skill, is able to decide how much of one kind of starch and how much of another is offered in the product under examination. It is a matter of congratulation that Nature has set herself so strongly against fraud in food stuffs as to record the origin of each grain of starch in the grain itself.

And that brings us to a consideration of that origin. We must accord to plants the exalted prerogative of being the exclusive and universal starch-formers in the world. Whether we note the

growth of the potato tubers or the plumping out of the grains of corn, wheat, or rice, the same fact remains that storehouses are being filled with the same organic compound. There must be many preliminary steps before this process of storing is complete, and for these we need to seek elsewhere in the growing plant.

Even the most careless observer can not but be at home with the fact that the whole port and bearing of ordinary plants is for sun exposure. They rise from the ground as closely placed stems of grass or less neighborly orchard or forest trees, and hang out their leaves to catch the sun. The economy of substance is so well studied that there is a very large exposure at a minimum of expenditure of tissue. In short, the leaves are the organs for association with the sunlight. They reach toward the sun where light is scanty, as in the window, and even turn their faces to the orb of day, shifting the position hour by hour from sunrise to nightfall. The rapidity with which we come to the fundamental fact that leaves are for the sun almost surprises one. The purpose is as easily inferred, but the steps in the process are not so quickly taken. The facts that leaves are *par excellence* the starch factories and the sunlight the inobtrusive chemist are granted, and it remains only to show something of the steps of proof that science may have discovered.

We need, therefore, to consider starch from the standpoint of its composition, and upon this the chemists are fairly well agreed. It consists of three elements, with their atoms so arranged that the molecule of starch has the composition of six parts of carbon, ten of hydrogen, and five of oxygen, or, to express the formula in terse chemical terms, it stands $C_6H_{10}O_5$. If we can account for the bringing of these atoms together in the production of a single molecule of starch the laboratory has been explored and the secret is ours, even if we can not put it to practical use in our so-called "starch factories."

The independent plant, beyond serious question, gets its food from outside itself. There are two sources for these substances—namely, the soil-water bathing the absorbing roots, and the atmosphere, with which the aërial branches and their leaves are constantly surrounded. From the soil come the water and all the salts, ash constituents, and the like that may be dissolved therein, while the gases of the atmosphere bring, among its chief contributions, a constant and, in an always exceedingly diluted form, the carbon dioxide, or, sometimes called, the carbonic-acid gas. This compound, familiar to us as a product of combustion, fermentation, and decay, is composed of carbon and oxygen, and has the symbol CO_2 associated with it by chemists.

In short, for the formation of our starch the water (H_2O) from the soil and the CO_2 of the atmosphere, when brought together, may be made to combine with the formation of starch. A single diagram, while not perhaps an absolute statement of fact, may serve to represent the final result:

$$\left\{ \begin{matrix} 6CO_2 \\ 5H_2O \end{matrix} \right. = C_6H_{10}O_5 + 12O.$$

In other words, the six molecules of carbon dioxide and five of water combine with the formation of one molecule of starch and the liberation of twelve atoms of oxygen.

This driving off of such a large amount of oxygen, entirely against the whole tendency of that element, it is assumed, is at the expenditure of much force. The only one adequate to this work is solar energy, and this is abundantly at hand. That we need not seek further for this power is proved by many and conclusive tests. Vegetable physiologists to-day are able not only to locate the sun as the chemist, that effects the changes necessary for the produc-

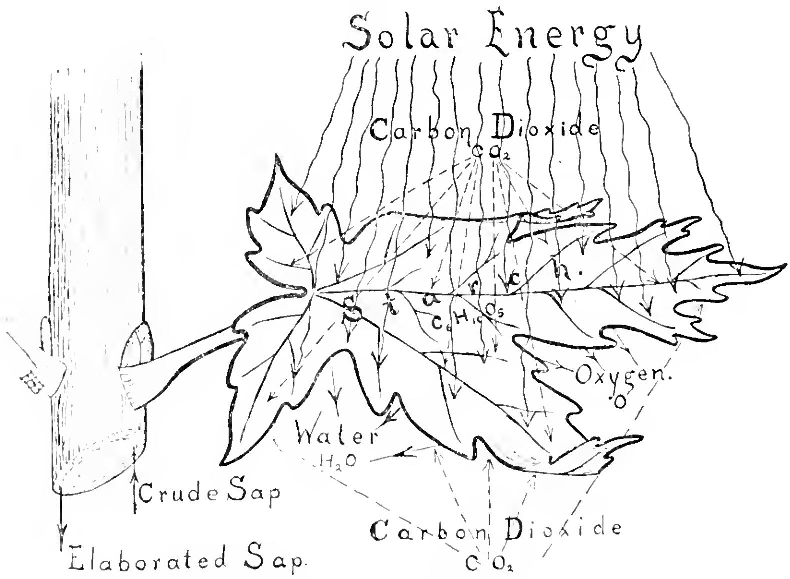

FIG. 5.—DIAGRAMMATIC VIEW OF THE PROCESS OF PHOTO-SYNTHESIS.

tion of starch, but can show in what cells and portions of those cells the forces effect the synthesis. The chlorophyll granules in the living cell are the microscopic laboratories in which a silent chemist, powerful beyond all measurements, builds out of inorganic materials the food substance of the whole world of animals and plants.

Fig. 5 is an attempt to present the above statements as to photo-synthesis in plants in such a form that it may appeal to the eye of the reader. A bit of maple twig is shown with one leaf in position. Passing up the stem in the young wood is the crude sap from the soil to the leaf. There is a downward flow of elaborated sap in the inner bark also represented. Solar energy is indicated by the wave lines as playing upon the upper side of the leaf, while the direction of the carbon dioxide is shown by the dotted lines entering from both above and below the leaf. Water of transporation is indicated as being given off, and upon a dry, hot day this is considerable, which, as it vaporizes in the tissue, tends to keep the latter cool. Lastly, with the formation of starch there is the escape of oxygen set free from the broken molecule of carbon dioxide or water or both in the formation of the starch.

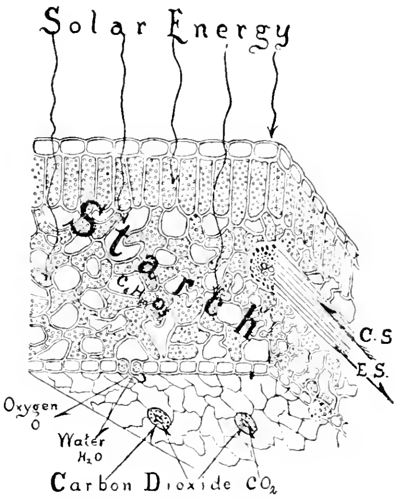

FIG. 6.—PORTION OF LEAF MAGNIFIED, ILLUSTRATING PHOTO-SYNTHESIS.

Fig. 6 is a similar attempt to show the process of starch formation with the use of a portion of the leaf in section as it might appear under the microscope. The under portion of the leaf is seen as having openings in the skin, through which the gases and vapors pass, and the middle portion above shows the porous nature of that part that is most active in synthesis. The small oval bodies in all the cells, except those of the upper and under epidermis, represent the chlorophyll granules, the special seat of the special activities which result in the formation of the carbohydrate, familiar to all as starch. To the right is a leaf vein, through which the crude sap (*c. s.*) reaches the synthetic cells, and the elaborated sap (*e. s.*) descends to places where it is needed for growth or for storage.

With the above facts in mind, there is no wonder at the activity that may reside in a field of corn during a bright day in August. Starch is being made almost by the ton daily, and, if the conditions favor, the next month will find a rich harvest for the husbandman who has assisted in supplying the conditions for the desired output of the leading carbohydrate.

The genuine starch factories of the world are exceedingly

small and equally numerous, and, with the sunlight as the active force, each green cell may contribute to the world's gain in the food substances that enable all creatures to live and move and enjoy a fairly comfortable existence.

TRADE CORPORATIONS IN CHINA.

By M. MAURICE COURANT.

THE remarkable longevity of a large number of business houses in China is not due solely to the general conditions of society or to those which are peculiar to the commercial class, but their stability and their fame rest upon a special organization, under which they are united in groups. It is customary for all the houses possessing the same specialty to form an association which I shall call a corporation, reserving to myself the privilege of pointing out a few exceptions to the rule. These corporations, which seem to date from at least three centuries back, are difficult subjects to study. Various in type, formed by the individuals interested, without the state having had anything to do with their regulations or even perhaps authorized them, they exist by force of custom and live conformably to their traditions, while some, I have been told, have written regulations and even, perhaps, archives—which they have not thought fit to communicate to the public. What is to be learned of them has, therefore, to be deduced from their visible transactions.

The corporation fixes the minimum price of articles of sale, and has secret agents to watch that no house takes less, thereby setting bounds to competition and preventing the injurious depreciation of goods. Only the public suffers from the existence of the minimum, but it does not seem to perceive it, and the Government never interferes except in respect to the price of grain, for which it fixes a maximum, and in times of great stress sells from its own granaries. The corporation, too, as represented in the banks and loan offices, fixes the rates of interest to be paid or received, and the kinds of securities and moneys that shall be accepted. In short, it adjusts the general regulations of business transactions, and defends the common interests of all those associated in it. If one of them is implicated in a judicial proceeding of general interest the corporation sustains him with its credit and its funds. It further takes in hand injuries to the interests of its associates. In 1883 the tea merchants' corporation of Hankow suspecting frauds by the agents of certain foreign houses, asked those houses

to designate themselves some foreigner to superintend the weighings. Notwithstanding the good reputation of the corporation and the moderation of its requests, the foreign houses refused. All transactions were suspended, and the official in authority declared that he could not compel the merchants to sell contrary to their wish, and the foreign houses were eventually obliged to yield, one at a time.

The corporations likewise watch the transactions of their members, oppose fraud which might harm the good name of the association so far that the silversmiths will not permit one of their number to sell alloyed jewelry, even when the purchaser knows it is such. Some see that the taxes and duties on production are regularly and properly paid. Others, in the interest of the stability of the houses, forbid all fictitious sales and purchases, and most of the stock operations and a large number of commercial transactions which seem very simple to us would not be tolerated by them. The custom of selling short having been introduced upon the silver exchange in Peking a few years ago, a censor reported it as a kind of gambling, and the Government interdicted the operation—a very rare example of official intervention. Under a similar old-fashioned view, the corporation of bankers inquires into the total amount of the notes issued by its members. Every banker and every broker is free to issue notes, and little attention is paid to the precautions required by the law. But the corporation has an infallible means of restricting extravagance in the emission of bills. If a house is going so fast as to be in danger of compromising its credit and perhaps endangering the capital of others associated with it, an order is given, all the notes are thrown before the public, and the imprudent bank has to suspend its payments and retire.

The corporation further maintains its reputation and keeps on good terms with public powers by expenditures on ceremonials and charities. Every year it appropriates a sum for the opening of the kitchens from which rice and millet broths are distributed to the poor of Peking. In case of famine or inundation, the quotas of the corporations do not have to be waited for, while the more prominent commercial men also contribute largely under their own names. They will subscribe for a testimonial to a mandarin who has done good service, will help prepare the road over which an imperial procession is to pass, and will contribute to the pageantry of popular religious ceremonials.

Each corporation has its patron divinity, who is the object of a special cult. With one it is the god of riches; with another Koan Yu, god of war; with others a spirit of more limited competency,

like Lou Pan, a famous mechanician of the time of Confucius, now patron of the carpenters. Adored in every shop by all the patrons and clerks, the festivals of the protecting genius are celebrated by the whole corporation at fixed dates. To some divinities a sacrifice of meats and incense is offered in each warehouse, after which all the chiefs and the men employed take part, while the spirit is supposed to be present. To others, more rarely, a more bountiful sacrifice is made in a temple, and the banquet, held in a large hall, is enlivened by dramatic entertainments. The patron is also duly honored in the celebration of the general feasts of the Chinese people.

The corporations have tribunals of arbitration and a common treasury, but the method of operation of those departments is among the things they do not reveal to the public. I have only learned a few general facts on the subject. The corporations intervene, I have been told, in the disputes of the members and to prevent dishonest dealings and attempts to cheat one another, but I have not learned that they have any real judiciary authority. Their treasury is sustained by means of assessments and fines, and loans may be contracted on its account, for the salt merchants of Tientsin are still paying interest on a number of debts contracted by the corporation in the last century.

Great differences might be expected to exist between the corporations in respect to these points and many others. They have been constituted at different epochs, independently of one another, and are similar only in their essential features. The minimum price fixed by the assembly is not equally imperative in all. Thus, the price fixed by the fur merchants at the beginning of the winter does not bind the members. In most branches of commerce all the houses composing the corporation are on a footing of substantial equality, though, of course, the large banks prevail over the small brokers, but there is no unlikeness in the business or the situation. The policy of the tea trade is mainly controlled in Peking by the houses of the families Fang and Oou. They fix the price, determine the equivalence of weight (the standard is a pound of four ounces instead of sixteen), and lead the corporation. In fact, the retail dealers use their capital in the decoration of their shops with gilding and sculpture, at a cost of between sixteen hundred and two thousand dollars, while the goods are lent them by one of the importers, who holds the decoration as security, so that the whole corporation is in the hands of these two families. This is a special condition, and there is nothing else like it, even among other importers of southern products. While most branches of trade are independent of official action, slaughter houses, of which

there are only five in Peking, have to be authorized by the Government. A religious motive may be at the bottom of this restriction, the large cattle being reserved for the imperial sacrifices. Moreover, the killing of animals has been interdicted at different times, and even now the slaughter houses are ordered closed, as an act of public penitence, in times of drought.

The loan houses also need an official authorization. They pay a tax on their operations to the local authorities, and are divided into three classes, according to the importance of their business. Those of the first class receive deposits from the authorities of various sums, on which they pay interest, the administration reasoning that by helping them increase their capital and enlarge their business it will be doing a philanthropic work and assisting the people. These loan offices are not at all like our pawnbrokers' shops, but are a credit institution, to which the middle class as well as the poor Chinaman has constant recourse. Being conducted on equitable terms and serving their convenience in various ways, they render great services to the Chinese people, and have become necessary to their life, and this explains the departure of the Government from its usual policy of non-interference to supervise and favor them. China has, further, large and small capitalists, and numerous credit establishments very much like ours. They may be classified as exchange offices, banks, and banks of discount. The last are at Peking, where they were founded a few decades ago by some men from Chan-Si. Their single industry is trading notes in all China and some of its dependencies. They have no monopoly, for some of the larger banks and more important traders were all doing the same; but they have regulated the business, extended it to more places, and have almost entirely suppressed the transportation of money in bulk.

The banks of exchange perform a variety of functions on a restricted scale, charging two per cent for exchanges, issuing notes without any supervision, and lending money at two per cent a month in normal times. They are not, however, always able to pay their notes at sight, and it is well, therefore, not to keep them too long. In the provinces a bank usually accepts only its own notes. In Peking some well-known signatures are accepted everywhere after examination by an expert, who places his seal on the note he declares good, charges a fee for each verification, and is responsible for his mistakes.

The large banks, by accepting or refusing the notes of any house or by throwing money or *sapiques* on the market, rule in the corporation and have the whole fate of the market in their hands. The four Hengs, by the amount of their reserve, the solidity of

their credit, and the number of their branches or correspondents, have no rivals in north China. All exchange operations are carried on in the money market, which is held every day in the southeastern part of the city, on the street, near the Tauist Temple, where all the houses in Peking are represented, and every one takes care to be so, lest he be thought in default. When the rate is fixed the news is dispatched by couriers, pigeons, etc., to all whom it concerns. The couriers of the corporation, who communicate with the brokers and bankers, are also the confidential agents of the syndics, are acquainted with the amounts of the emissions of each house, know whether a certain patron is really ill or only feigning, and by their reports decide who shall be boycotted or declared insolvent. All this goes on in full liberty, without surveillance by the state, without any tax on the transactions, and without any other interference than the prohibition of fictitious dealings. The corn market is in the same way the almost exclusive domain of the corn corporation, the state never interfering except in the case of a famine in the region.

Besides the merchants' corporations, there exist also corporations of artisans. The embroiderers, the makers of *cloisonné*, the tanners, and the carpenters have theirs. The carriers and the boatmen, who, before the opening of the railway, had the monopoly of transportation between Peking and the provinces without forming associations, met at their respective inns and established rules and rates for their business. Informal organizations, varying among the different towns in their degrees of development, exist among the barbers—who at Peking meet every year for a sacrifice and a banquet—the chair-bearers, and the *jinrikisha* men, and so every city has its corporations and associations which are not like those of the next city.

Some branches of trade have no corporations, and the peasants, when they come to town to sell their produce, trade on their own account, for the best terms they can get, and have to accept, in the market, an organization the origin of which is forgotten. Every year, on the appearance of each sort of crop, the *King ki* of the market, having agreed with the dealers, fixes the minimum price of the commodity for the season. He also polices the market. The function of *King ki* is the property of the person who exercises it, who has bought it from his predecessor and will sell it to his successor by private contract, and nobody contests his right. In the market for *azaroles* the position is hereditary. The monopoly of the corporations is often complicated with a provincial question. The Chinaman regards every man who was born in another district as a foreigner—still more if he is of another prov-

ince. Those who are of the same local origin, on the other hand, stand by one another. Hence it has come to pass that some trades have been monopolized by the people of some one province. Most of the bankers were originally from Chan-Si; all the great merchants came from Anhoei. The people of Chan-tung have three special occupations in Peking. They have the exclusive privilege of killing pigs and retailing meat. They are the only water carriers, each one having his well on the public highway, his watering place for horses and mules, and his district where he sells water without permitting the people to provide for themselves elsewhere. Such privileges are consecrated by usage and zealously defended by their holders, and respect for them is enforced, when necessary, by the authorities. Associations are formed, also, even among the coolies who work on the docks.

These details show by how great a variety of forms all the corporations assure the same result—the organization of labor. We see also how they extend beyond commerce. The Chinaman is in fact a social being bound closely to his fellows—of the family, province, trade, or class—by every tie and in every sphere of life. He is never a man living by himself and for himself, and is not accustomed to independence. Hence the authority of the corporation, instead of seeming strange, is a necessity to him. Consequently the corporation has the right, by universal consent, to exact obedience from its members, and to compel those who would stay out to come into it.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

M. L. Azoulay suggests, in the *Revue Scientifique*, that the invitation given to Señor Rámon y Cajal, the celebrated Spanish neurologist, to visit the United States and attend the celebration of the tenth anniversary of Clark University, furnishes a good example for France to follow. "It causes grievous chagrin to me to think," he says, "that while Germany, England, Austria, Switzerland, and the United States are regularly accustomed to invite to their scientific ceremonials, of which there are more than one every year, students of other countries who have illustrated any branch of human knowledge, France, formerly so hospitable, refuses these international appeals."

At the recent meeting of the British Archæological Association, at Buxton, Dr. Brushfield described the prehistoric circle of Arbor Low as, upon evidence which he cited, the earliest neolithic monument in Britain. There are thirty-two stones in the circle, all now lying prostrate, but they must originally have been erect. The dolmen in the center is now level with the ground. The mound and ditch—the latter being inside, between the mound and the stone circle—are in a very perfect condition, notwithstanding the lapse of time. The work has two openings—on the northeast and southwest.

Editor's Table.

SCIENCE AND DOGMA.

AFTER many uncomfortable turnings in his narrow theological quarters, the eminent biologist, Professor St. George Mivart, seems to have made up his mind that he may as well, before he dies, know what it is to enjoy the air of liberty. For many years he has been pining for this, and almost inviting the authorities of the Church to give him his passports. The Church was not anxious, however, to quarrel with a man of recognized ability and wide knowledge, and therefore writings which might well have been expected to give serious umbrage were allowed to pass unnoticed. The professor then made a most audacious raid upon the venerable doctrine that there remains for the majority of mankind a place of unutterable and eternal misery. He ventured to speak of The Happiness in Hell, maintaining that, while the inhabitants of that abode would always have a profound and harrowing sense of having missed the supreme happiness of heaven, they would still be able to occupy themselves in a variety of ways which would give them a certain amount of happiness, just as in this world a man may carry a profound sorrow in his heart and yet, under the stimulus of business or society or intellectual study, have his attention happily diverted for many hours every day. At this point the authorities drew the line. It is related of an old Scotch lady that, referring to the Universalists, she said, "Those people say that all men will be saved at last, but *we* hope for better things." Whether this was the point of view of the ecclesiastical powers or not, certain it is that they refused to sanction the notion of any happiness, of howsoever humble an order, in the abode of gloom, and gave a peremptory order to the professor to take it all back. Well, he took it back as a matter of submission to those whom he regarded as his lawful spiritual guides, but the submission did not give him rest. If ecclesiastical authority was entitled to respect on one side, science was urging even stronger claims on the other. In August last, as we now learn, the professor wrote to the Prefect of the Sacred Congregation of the Index, explaining how he wished his submission to be understood, and as he and the prefect could not come to an agreement about it, he withdrew the submission altogether. Then he resolved to relieve his mind. It took two articles in two separate magazines to do it—one in the Fortnightly and one in the Nineteenth Century—but then it was done in a manner admitting of no recall. No sooner had these articles appeared than Cardinal Vaughan drew up an iron-clad declaration affirming the falsity of every position the writer had taken, and required him to sign it. Too late! The biologist and evolutionist in Professor Mivart had finally triumphed over the theologian, and he met the cardinal's demand with a flat refusal. Thereupon his Eminence issued an order excluding the recalcitrant *savant* from the sacraments of the Church.

Mr. Mivart now knows where he is. He occupies the broad ground of scientific truth. He breathes the free air of intellectual and moral liberty. He still professes loyalty to the Church according to his own conception of it, but he will no

longer bow down to an authority that assumes to prescribe his opinions in matters which he is quite capable of judging for himself. He has arrived at the conclusion that even as regards the interpretation of Scripture the Church is just as liable to err as the humble layman. He quotes most persistently the case of Galileo, in which the Church, in the most formal and official manner, declared that Scripture taught what for nearly a century now it has admitted Scripture does not teach. If the highest organs of ecclesiastical authority could make such a blunder in Galileo's day, what blunders may they not commit in our day? But if the Church can err egregiously in what is its own peculiar province—if anything is—how great is likely to be its inaptitude when it undertakes to deal with scientific questions!

"God has taught us," says Mr. Mivart, "through history, that it is not to ecclesiastical congregations but to men of science that he has committed the elucidation of scientific questions, whether such questions are or are not treated of by Scripture, the Fathers, the Church's common teaching, or special congregations or tribunals of ecclesiastics actually summoned for the purpose. This also applies to all science—to Scripture criticism, to biology, and to all questions concerning evolution, the antiquity of man, and the origin of either his body or his soul or of both. For all ecclesiastics who know nothing of natural science it is an act necessarily as futile as impertinent to express any opinion on such subjects."

The opposition of the rulers of the Church to the true theory of the solar system in the sixteenth and seventeenth centuries is paralleled, according to Mr. Mivart, by their opposition to the doctrine of evolution to-day. He refers to the fact that two Catholic professors who had ventured to give a partial support to the doctrine in question—one of them Father Zahm, who contributed an article, as many of our readers will remember, to this magazine a couple of years ago—had both been compelled to retract and disavow what they had published on the subject. Professor Mivart draws a distinction, however, between the rulers of the Church and the Church. The latter he idealizes—and we by no means dispute his right to do so—as a vast organization the office of which is to keep alive man's sense of spiritual things, and to bear eternal testimony in favor of those truths of the heart which do not admit, like intellectual truths, of logical demonstration. Though cut off by authority from participation in the rites of the Church, he feels himself still one in sympathy with all who in the Church are aspiring to a higher life. We look upon his case as a very instructive one, affording as it does clear evidence of the absolute incompatibility between any authoritative system of dogma and the free pursuit of truth. It has taken Professor Mivart a long time to arrive at his present standpoint, but it is well that he has got there at last. His example, we believe, will encourage not a few to assert in like manner their right to think freely and to utter what they think.

A MORE EXCELLENT WAY.

When our article of last month, entitled A Commission in Difficulties, was written we had not seen the paper by Mr. Theodore Dreiser, in Harper's Magazine for February, describing the important educational work which the Western railways are doing with a view to promoting the prosperity of the agricultural regions through which they pass. In our article we observed that "the more interference there

is between parties who, in the last resort, are dependent upon one another's good will, the less likely they are to recognize their substantial identity of interest." What Mr. Dreiser clearly shows is how great the community of interest is between the railroads on the one side and the farming community on the other, and how fully that community of interest is recognized by the railways at least. The freight agent of a given line is charged with the duty of developing to the utmost—in the interest, primarily, of his road, it may readily be granted—the agricultural resources of the country through which it runs. He has his assistants, who look after different branches of the work, such as crop-raising, cattle-grazing, dairying, poultry-raising, etc. "Through this department," the writer says, "the railroads are doing a remarkably broad educational work, not only of inspecting the land, but of educating the farmers and merchants, and helping them to become wiser and more successful. They give lectures on soil nutrition and vegetable growing, explain conditions and trade shipments, teach poultry-raising and cattle-feeding, organize creameries for the manufacture of cheese and butter, and explain new business methods to merchants who are slow and ignorant in the matter of conducting their affairs." An agent of the railway will visit every town along the line a certain number of times every year to see what he can do to quicken trade. Finally, in the great centers there are special agents who "look after incoming shipments, and work for the interests of the merchants and farmers by finding a market for their products." Examples are given showing how the railways are able to impart, and do impart, information of the highest value to the farmers, such as puts them in the way of getting greatly improved returns from their land.

Of course, the railways want business, but it is eminently satisfactory when one party who wants business uses his best efforts on behalf of another in order that by making him prosperous he himself may prosper. When things get into this shape they are all right, as the phrase is. The accepted definition of a perfect action is one which benefits all who are parties to it. Things are on a much better foundation when people are mutually benefiting one another, each primarily in his own interest, than when it is all philanthropy on one side and passive acceptance of benefits on the other. Philanthropy is an uncertain thing, and its effects are uncertain. Its quality will take, in general, a good deal of training; but business, on an honest and reciprocally helpful basis, is good all through.

It is a happy circumstance that there are natural laws and forces at work which tend to produce a healthful social equilibrium. The true statesman is he who is on the watch to discern these forces and these laws, resolved that if he can not aid their operation he shall at least throw no obstacle in the way of their activity. The amount of harm that is done by coming between people who would be certain to arrange their business relations satisfactorily, if they were only left to do it without interference, can hardly be estimated. Man is fundamentally a social animal, and he wants, if he can possibly get it, the good opinion of his fellows. This is a principle which legislation too much overlooks, but it is one on which, as we believe, the future progress of society depends, and which, in spite of the blunders of legislators, will more and more assert itself as the years go on.

Fragments of Science.

Religious Suicides.—Suicides from religious fanaticism, which are still prescribed by some sects, are compared, as having a common origin, with propitiatory or expiatory human sacrifices, by Herr Lasch, in an article of which we find a review in the *Rivista Italiana di Sociologia*. Voluntary sacrifices, which abound in the history of ancient peoples, had nearly always in view the removal of perils or the cessation of public calamities by appeasing the anger of the divinity through the offering of a human victim. Thus Macaria, the daughter of Hercules, at Athens during the Peloponnesian war, and Codrus and the Athenian youth Cratinus voluntarily offered their lives to aid their country by the sacrifice. The consul Decius gave himself up to assure victory to his legions, and Adrian's favorite Antinous to save his imperial protector. Spontaneous offerings of human victims to appease offended divinities are mentioned in the traditions of the ancient Germans, and it was usually their chief or king who suffered for the good of the people. Offerings of this sort are far from infrequent among barbarous and half-civilized peoples. Among some tribes in China a man is sacrificed every year for the public welfare. Such voluntary renunciations of life to acquire merit with the divinity, to gain favors, to atone for sins, and fulfill vows are very common in India, particularly where Brahmanism is most influential. Special methods were pointed out in the Hindu laws for performing such sacrifices as would be sinful for a Brahman, but not for a Sutra, who, before abandoning life, should make gifts to the Brahmans. A favorite method was to drown one's self in the Ganges, and particular spots in the river were designated for this act. The sacred books mention five methods of performing sacrifice to assure a better fortune in the next life: Starving to death, being burned alive, burial in snow, being eaten by a crocodile, and cutting the throat or being drowned at a particular spot in the Ganges. In fulfillment of vows, sons would sacrifice themselves for their mothers by jumping from a rock. To keep up the courage of the victim, the Sivaitic rituals promised many beatitudes to him who courageously met death for his sins, and threatened eternal punishment to one who performed the sacrifice in a base manner. And when the suicide had been decided upon they allowed no retreat or repentance, but forced its consummation. A special apparatus for suicide formerly existed in some of the villages in central India, consisting of a guillotine which the victim himself set in action. Casting one's self under the wheels of the car of Juggernaut was another method of religious suicide. Some philosophical schools prescribed subjection of the body to various pains for the purification of the soul; and the books of Manu, which also impose the destruction of human sensibility, have contributed much to preserve this idea in India and spread abroad, especially in the Malay Archipelago, the usage of voluntary sacrifice to the divinity. The aborigines of the Canary Islands have employed voluntary sacrifices on the coming of an epidemic, and the ancient Mexicans and Peruvians observed them in honor of the divinity.

"Manuring with Brains."—"New Soil Science" is the name Mr. D. Young gives, in the Nineteenth Century, to the results of the studies of soil bacteriology prosecuted by Mr. John Hunter and Professor McAlpine on Lord Roseberry's estate of Dalmeny, and "manuring with brains" to the application of them. Attention has been called to the value of the bacteria in the soil as nitrifying and fertilizing elements by the experiments of Sir John Bennet Lawes and Sir Joseph Henry Gilbert at Rothamsted, and more forcibly by experiments coming after them but suggested by them. It had also been found that caustic lime used upon the soil is liable to destroy the nitrifying and other advantageous organisms, while carbonate of lime is surely useful, and a due proportion of lime compounds is essential to the best discharge of their functions.

The discovery that the bacteria of the root nodules of leguminous plants possess the power of absorbing the free nitrogen of the atmosphere and rendering it available for the use of the plant was made by Messrs. Hunter and McAlpine, according to Mr. Young, and was taught by them to their students several years before Hellriegel, to whom it is usually ascribed, fell upon it. They found that several well-defined sets of bacteria were concerned in the work of nitrification, and isolated and cultivated the nitrous germ, but could accomplish nothing with the nitric germ till they used old mortar or some lime dressing with it. They also found that lime compounds in the surface soil served a further important use by preventing the soluble silicates from being taken up by the roots of the plant, the lime taking up those salts and forming insoluble silicates which were retained in the soil and did not diffuse into the plant. So a non-silicated stem, or a cellulose stem, was formed, which would bend before the wind without breaking, while the non-silicated straw was much superior in value to the silicated straw. Messrs. Hunter and McAlpine denied that silica in the plant gave strength and solidity to the stem, and pointed out that it rather, like glass, made the straw brittle. They found out, further, that large quantities of carbonic acid were produced in the soil through the operation of the ferments, and found an outlet through the subsoil drains. They made other discoveries which threatened to render it necessary to revise the whole fabric of agricultural science, and were called to account by the institutions in which they were teachers for their heresies. They maintained their position till the opportunity came to them to make tests of their theories on Lord Rosebery's Dalmeny farm. Among the results of the Dalmeny experiments are proof of the value of a dressing of ground lime in proportions not large enough to kill the bacteria, emphasis of the value of potash for every crop, and the discovery of a remedial treatment for the finger-and-toe pest in turnips. "When these experiments were commenced, ground lime for agricultural purposes had never been heard of, whereas now there are at least six lime works where extensive grinding plants are kept hard at work to supply the ever-increasing demand for that substance. Since the principles for the new soil science have been put in successful practice at Dalmeny the scientific authorities, who at first had branded these principles as absurd heresies, have changed their tune," and now the chemical adviser of the Highland Society has declared that he accepts the new doctrines.

Plague Antitoxin.—In justifying his belief in the efficacy of the inoculation treatment against the plague, Lord Curzon, the Viceroy of India, said, in a recent address at Poonah: "If I find, as I do find, out of one hundred plague seizures among uninoculated persons, the average number who die is somewhere about seventy to eighty per cent, while, in a corresponding number of seizures among inoculated persons, the proportions are entirely reversed and seventy to eighty per cent, if not more, are saved—and these calculations have been furnished from more than one responsible quarter—I say figures of that kind can not fail to carry conviction; and I altogether fail to see how, in the face of them, it is possible for any one to argue that inoculation is not a wise and necessary precaution." He had been personally visiting the plague hospitals and camps about the city, and had already supported his advocacy of this treatment by having himself and his party inoculated at Simla with the plague antitoxin.

Cultivation of India Rubber.—An article in the Bulletin of the Bureau of American Republics represents that there are lands in Mexico and Central America equally adapted to the cultivation of the India-rubber tree with the Brazilian plantations, and having, in addition, a salubrious climate. Formerly dependence for the supply of India rubber was placed in the product of wild trees, but with the increase in the uses for it, and the consequent rise in prices, capital is being invested in this industry, and its profitable cultivation is being largely engaged in. The trees do not flourish at an elevation exceeding five hundred feet above sea level, and low land, moist but not swampy, is the best. Land suitable for planting

could be bought for twenty-five cents an acre in large tracts, but it now brings from two dollars to five dollars Mexican. These lands can be used for other crops while the trees are growing up, and thus made partly to repay the cost of starting the plantation. So the expense of clearing the land preparatory to planting it is largely met, if facilities for transplantation are at hand, by the sale of the dyewoods, sandalwood, satinwood, ebony, and mahogany that are cut off. The land should be chosen along the banks of streams, where the soil is rich, deep, and loamy, and the presence of wild rubber trees is a sure indication of its suitability. These wild trees should be left standing, and young seedlings should be kept and transplanted into their proper places. The densest plantation compatible with good results is fifteen feet apart, giving about one hundred and ninety-three trees to the acre. Once in the ground, the tree needs no attention or cultivation beyond keeping down the undergrowth, which can be effected by the aid of a side crop. The tree propagates itself by the seeds or nuts, which drop in May and June. By the sixth or seventh year the grove will be in bearing, and thereafter should yield from three to five pounds of India rubber per tree.

The New York Botanical Garden's Museum.—The museum building of the New York Botanical Garden is substantially completed, and most of the works are in an advanced state of forwardness. The museum cases (for public inspection) and the herbarium cases (for students) are in position, and the herbarium cases are filled. Among the recent gifts of value to the institution are the miscellaneous collection of John J. Crooke, made about thirty years ago and containing about twenty thousand specimens, among which are a set of the plants obtained by the United States Pacific Exploring Expedition of about 1850; the collection of between twenty and thirty thousand specimens made by Dr. F. M. Hexamer in Switzerland and the United States; a collection of seven or eight thousand numbers, made by Mr. and Mrs. A. A. Heller, representing between twelve and thirteen hundred species, some of which are new to science; and specimens of crude drugs, for the Economic Museum, presented by Parke, Davis & Co. A permanent microscopic exhibition is to be established by Mr. William E. Dodge, at his own expense. It will be furnished with at least twenty-five microscopes, and with specimens carefully prepared and inclosed, to secure them from injury. A set of more than two hundred volumes on botany and horticulture, which formed a part of the library of Dr. David Hosack, founder of the first botanical garden in New York, has been presented by the New York Academy of Medicine, which received it from the New York Hospital.

Action of Sea Water on Cements.—As the result of examinations of many masonry structures immersed in sea water, Dr. Wilhelm Michaelis has found that Portland cement does not resist the chemical action of such water so well as do Roman cement and the hydraulic cements. The soluble sulphates in the sea water appear to enter into a substitution combination with the lime which exists in the cement in a free state or is liberated in the hardening, and it is converted into a sulphate, while disintegration ensues. In Roman cement the lime exists in combination, and there is no inclination toward the formation of a sulphate, and hydraulic limes resemble Roman cement in physical qualities. Dr. Michaelis suggests that hydraulic cementing materials containing more lime than is required for the formation of stable hydro-silicate and aluminate may be made suitable for submarine work by an admixture of trass or puzzolana, whereby the cementing strength of the mass will be greatly increased, and it will be enabled to withstand the disintegrating action of the sea water.

Stories of Amazonian Pygmies.—Dr. D. G. Brinton subjected the stories of the existence of pygmy tribes on the upper tributaries of the Amazon to a careful examination, and came to the conclusion that the facts did not show anything more than that there are undersized tribes in that part of South America, with occasional individual examples of dwarfs, such as occur in all communities. It is still a question, he observed, "whether the rumor of a pygmy people somewhere in the tropical for-

ests is not to be classed with the stories which threw a strange glamour about those inaccessible regions in the early days of the discovery. There were many of these, for I am speaking of the part of the map where was located the El Dorado, the golden city of Manoa, the home of the warlike Amazons; where dwelt the men with tails and the mysterious *Oyacoulets*, warriors with white skin, blue eyes, and long, blond beards. All have vanished from history but the pygmies, and their turn will probably soon come."

Relief and Pension Funds of Railroad Men.—In instituting a pension fund for the men in its employ the Pennsylvania Railroad established, in addition and supplementary to the relief fund of which they enjoy the privilege, a special fund for those who are retired or superannuated, which is adjusted according to their length of service and the pay they have been receiving. The relief fund affords every man employed an opportunity to provide for himself in case of sickness or disability. It is co-operative, and is supported jointly by the employed men, its members, and the company, the expenses of operation and the deficiencies in it being met by the company. The additional pension is the company's own undertaking. Besides the manifestly humane purpose of this arrangement—to care for the present and future interests of its men—it promises to work to increase and improve the effectiveness of the company's service. Its tendency will be to give the men greater heart in their work, and to cause them to identify themselves more fully with it. Decent provision being made for the retirement of old hands, the service can be kept manned by a younger and more robust class. The new fund will effect the entire force on the lines of the Pennsylvania system east of Pittsburg and Erie, extending over a trackage of more than forty-one hundred miles.

The Broom as a Spreader of Disease.—Dust being now generally recognized as one of the most efficient vehicles of the germs of disease, Dr. Max Girsdansky finds the broom to be one of the most active agents in sending them into air, where it is diffused by whatever breezes may be blowing there. The housewife digs the dust out of her carpets and stirs it out of the quiet corners where it has accumulated, wearing an old dress and covering her head while she leaves her lungs exposed, then shakes her rugs in the yard, and the street sweeper transfers the dust he has charge of from the pavement to the atmosphere, where we can breathe our fill of consumption from day to day. Therefore, the author holds, the broom, "far from serving any hygienic purpose, is the cause of the maintenance of organic dust in the atmosphere of the large cities of the world, and as such is the most important cause of the existence and spread of tuberculosis." Further, the carpet is pronounced "an unhygienic article, serving as a fine breeding ground for vegetable parasites, necessitating the use of the broom and the duster, and thereby becoming a reason for the existence of organic dust." As the only proper and safe way of procuring the cleanliness of the floors and streets of our large cities, Dr. Girsdansky advises the free use of water in the shape of showers, or with sprinkling wagons, hoes, mops, etc., and that all floors and floor coverings of the house and the street be so constructed as to facilitate the free use of water in these ways.

Alkali Soils in Montana.—Mr. F. W. Traphagen, of the Montana Agricultural Experiment Station, ascribes the origin of the alkali soil in the arid regions to the failure of the elements to remove the soda salts set free on the disintegration of the rocks, which in humid regions are taken up and washed away by the rains. The soluble salts are dissolved by the water that falls on the surface, and are carried down when it soaks through the ground, to form an element in the ground water. They return thence to the soil when water is brought up by capillary action to supply the place of that lost by surface evaporation, and accumulate there. Then, as the water evaporates they are left on the surface, forming, when in sufficient quantity, the white crusts seen in badly alkalied places. The most effective remedy for alkali might probably be found in underdrainage, which would prevent the ground water rising

to the top, and would carry off the salts. This being at present impracticable on the large scale that would be required, such expedients as surface flooding and such cultivation of crops as would tend to check evaporation are suggested. The pernicious effects of "black alkali" or sodium carbonate are seen when it forms as much as about one tenth of one per cent of the soil, in the corrosion and solution of vegetable matter—the stems of plants—exposed to it. It also dissolves the humus or vegetable mold, forming dark-colored solutions and depositing a black residue upon the evaporation of the water—whence its name—and it destroys the tillability of many soils. The "white alkali" or sodium sulphate can be borne in much larger proportions in the soil, and promotes the best crops just before it completely destroys them. The author remarks that the foundations of a number of buildings in Billings, Montana, are gradually becoming insecure because of the disintegration of the rock, due to the absorption of alkali salts, followed by the evaporation of the water and the deposit of salts within the pores of the rock. As the process continues, the rock particles are forced apart.

Future of the New York Canals.—The Committee on Canals of New York State recommend decidedly in their report to the Governor that those highways should not be abandoned but maintained, and the principal ones enlarged, while the others should be kept up as navigable feeders. Of two projects for enlarging the Erie Canal, that undertaken in 1895, with modifications to be executed at a cost of $21,161,645, and a larger one to cost $58,894,668, the committee prefer the larger one, because it will permanently secure the commercial supremacy of New York, while the other is "at best only a temporary makeshift." An important principle emphasized in the report is that the efficiency of the canals depends upon their management as well as upon their physical size. Therefore a policy should be followed that will encourage transportation companies to seek the use of them; mechanical means of traction should be employed, and mechanical power should be substituted for hand power in certain operations; the force engaged upon them should be organized on a more permanent basis of fitness, so as to furnish an attractive career to graduates of scientific institutions; and efficient guards should be thrown over the expenditure of money "so as to make impossible a repetition of the unfortunate results of the $9,000,000 appropriation."

Floating Stones.—While engaged in scientific research in southwest Patagonia, Mr. Erland Nordenskiold observed a considerable number of small fragments of slate floating upon the surface, packed together in larger or smaller clusters. The surface of the stones was dry, and they sank immediately when it became wet. Their specific gravity was 2.71, that of the water being 1.0049. The fragments contained no air cavities perceptible to the naked eye, but small, gaseous bubbles could be seen attached to their under surfaces, and stones on the very fringe of the beach which were just beginning to float were observed to be lightened by gaseous bubbles. The author was not able to investigate the phenomenon more closely, but believes that besides the visible bubbles they were surrounded by an envelope of gas, supported by an insignificant coating of algæ, by which they are enveloped. The greasy surface of the mineral also prevented the water from adhering to them, and caused them to be surrounded with a concave meniscus, which contributed much to their floating.

The "Periodicity of War."—The doctrine of "the periodicity of war" was presented at the Lake Mohonk Conference on International Arbitration in May–June, 1899, by General Alfred C. Barnes, with the introductory remark that "no one deprecates war more than the soldier who serves from a sense of duty." The speaker said that "with all our privileges, and in spite of the elevated spirit that undeniably prevails among us, the original savage lurks in the hearts of men here as elsewhere." In two hundred and twenty-five years we have had ten principal wars—five during the colonial period and five since our independence was undertaken. The average interval between wars has been about twenty years—"an extremely in-

teresting periodicity, as it brings into the arena a new race of fighting young men. So it seems that for each fresh generation of our youth the temple gates of Janus have to be opened, that the furies there confined may rush forth and devastate the earth. It looks almost like the operation of a natural law." General Barnes's theory of the origin of the war that the United States is still engaged in is the simple one that we were "spoiling for a fight."

Expert Opinions respecting Food Preservatives.—At a recent hearing before an English Official Committee on Preservatives and Coloring Matters in Food, the representative of an eminent firm of preservers said that preservatives were not very generally used with fruits and jams. His firm regarded them as quite unnecessary, but he would not say they ought to be prohibited if used in moderate quantity. Besides coloring matter in vegetables, the only article used by his firm for coloring was an extract of cochineal. Mr. John Tubb Thomas, a medical officer, told of children who were injured by milk containing boracic acid, and said that in his experiments upon himself about fifteen grains of that substance a day had upset his digestive organs and produced sickness, with diarrhœa and headache. The use of the acid, he said, should certainly be prohibited in new milk, which was so largely the food of invalids and infants. Dr. W. H. Corfield said he had found salicylic acid in the lighter wines and beers. It was a slightly acrid, irritating substance, which was used externally for the removal of corns and warts, and was a most undesirable article to put in food. Mr. Walter Collingwood Williams, a public analyst, had found salicylic acid in a number of temperance, non-alcoholic drinks. Dr. Kaye, a medical officer of health, showed that the number of infant deaths was increasing, while the general death rate was decreasing, and attributed the fact, partly at least, to the growing and excessive use of preservatives.

Pawnshops in Germany.—Between half a dozen and a dozen of the state pawnshops which were common in Germany in the seventeenth and eighteenth centuries still exist. The United States vice-consul at Cologne has given a considerable list of municipal pawnshops in the more important cities of all parts of Germany. On the whole, the number of these institutions is larger in Germany than in France, but smaller than in Belgium, Holland, and Italy. The business of pawnshops appears, at least more recently, to depend less upon general economic than on special, local causes. The German law has usually required private persons doing a pawnbroking business to take out special licenses, and has exercised a more or less strict supervision over them. The supervision practically lacked efficiency, and more stringent regulations were imposed by a statute enacted in 1879, which is now the basis of the existing law of the German Empire. Under this law license is refused to persons who are unfitted for the business, and is not issued at any rate unless a necessity is shown for the institution. The imperial law is supplemented by special laws of the various German states.

Animals of the Ocean Depths.—While plant life in the ocean is limited to shallow waters, Sir John Murray says fishes and members of all the invertebrate groups are distributed over the floor of the ocean at all depths. The majority of these deep-sea animals live by eating the mud, clay, or ooze, or by catching the minute particles of organic matter which fall from the surface. It is probably not far from the truth to say that three fourths of the deposits now covering the floor of the ocean have passed through the alimentary canals of marine animals. These mud-eating species, many of which are of gigantic size when compared with their allies living in the shallow coastal waters, become in turn the prey of numerous rapacious animals armed with peculiar prehensile and tactile organs. Many deep sea animals present archaic characters; still, the deep sea can not be said to contain more remnants of fauna which flourished in remote geological periods than the shallow and fresh waters of the continents.

The Site of Ophir.—Dr. Carl Peters, an African explorer recently returned to London, believes that he has

found the Ophir whence King Solomon's gold was brought, in the country between the Zambesi and the Pungwa Rivers, in Portuguese Africa and eastern Mashonaland. Many rivers, some quite extensive, of undetermined origin, and traces of ancient mining enterprises, are found in the region, and gold is still washed there. One site is Fura, on the Muira River, about fifteen miles south of the Zambesi. The name Fura is said to be a native corruption of the word Afur, by which the Arabs of the sixteenth century called the district, and that to be the Saharan or south Arabian form of the Hebrew Ophir. The natives are unlike the ordinary Africans, and have a distinctly Jewish type of face. A chief informed Dr. Peters concerning the position of some ancient workings, and, following his directions, the explorer found ruins "of an undoubtedly Semitic type." Dr. Peters's hypotheses and evidences must be accepted for what they are worth. Other explorers have found Ophir at various points in Africa and Arabia, and even in India and elsewhere, and have been as satisfied and as sure as he with their identifications.

MINOR PARAGRAPHS.

An instructive address, before the Iron and Steel Institute of Great Britain, was recently delivered by Sir W. Roberts Austen on the progress made in the iron and steel industries during the past century. The great revolution which the discovery of steel brought about is dwelt upon at length, and its far-reaching importance, not only in the iron industry itself but in all other industries and in the destinies of England herself, pointed out. In the early days of the industry it was held that the different qualities of iron were due to the different localities from which the ore was obtained, but late in the eighteenth century the great Swedish chemist, Bergman, of Upsala, clearly showed that carbon is the element to which steel and cast iron owe their distinctive properties. Clouet's celebrated experiment on the carburization of iron by the diamond followed. "Well might Bergman express astonishment at the action of carbon on iron. Startling as the statement may seem, the destinies of England throughout the century, and especially during the latter half of it, have been mainly influenced by the use of steel. Hardly a step of our progress or an incident of our civilization has not in one way or another been influenced by the properties of iron and steel. It is remarkable that these properties have been determined by the relations subsisting between a mass of iron, itself protean in its nature, and the few tenths per cent of carbon it contains." In 1800 the production of pig iron in England was about 200,000 tons; in 1898 it was 8,769,249 tons.

A note in Nature describes an ingenious arrangement for controlling the direction of torpedoes by means of ether waves. Two solenoids, into which are drawn iron cores, are attached to the rudder head, the core which is drawn in depending, of course, upon the direction of the received current. Two rods projecting above the surface of the water receive the waves and are in circuit with a coherer of special type, which affects a relay in the usual way. The actual processes involved in steering and controlling a torpedo are somewhat as follows: The torpedo, containing a suitable combination of the apparatus above mentioned, is launched from a vessel containing the necessary sending apparatus. Suppose the torpedo goes off its course. Then, by means of a switch, an induction coil is supplied with an electric current, and waves or oscillations are generated. These, on reaching the torpedo, pass into the projecting wire and thence reach the coherer. This operates the relay, closing the secondary circuit. An electric current now flows through a "selector" to one of the solenoids, the iron core is sucked into right or left, and the helm is thus turned. When the torpedo has attained a proper course the switch is opened and the waves cease. The vibration in the neighborhood of the coherer restores it to the original resistance; the current passing through it becomes weaker and ceases to affect the relay coil, which therefore opens the secondary circuit and allows the helm to fly back to the midship position. A large model of the apparatus has been constructed, and it is said to work with en-

tire success under all kinds of conditions. The inventors are Mr. Walter Jameson and Mr. John Trotter. It is stated that Nikola Tesla has American patents for a somewhat similar device.

In the absence of the author, Professor Dewar's paper on the solidification of hydrogen was read in the British Association by Sir William Crook. It shows that solid hydrogen presents the appearance of frozen water, and not, as had been anticipated by many, of frozen mercury; hence it is now definitely decided that it is not metallic. The temperature of the solid is 16° absolute at thirty-five millimetres pressure, and it melts at 16° or 17° absolute, the practical limit of the temperature obtainable by its evaporation being 14° or 15° absolute. Thus the last of the old gas has been solidified. It was further mentioned, in connection with these statements, that Professor Dewar had succeeded in liquefying helium.

The organizing committees of the Congresses of Aëronautics and Meteorology—these being cognate subjects—of the Exposition of 1900 have decided to hold the meetings of these bodies in such a manner that all members can attend the sessions of both. The programme arranged for the Aëronautical Congress contemplates the discussion, under aspects which are set forth in detail, of "problems" relating to free balloons, their management and use; captive balloons, steerable balloons, and aviation; and the scientific applications of balloon observations to problems in astronomy, meteorology, and physiology; also of their use for purposes of reconnoissance and topographical surveys, and of photography from balloons. In a different order of ideas, the congress may occupy itself with questions of legislation and international law which concern aëronauts in times of peace and of war.

Three State catalogues of Ohio plants have heretofore been issued. The first, by J. S. Newberry, was published in the State Agricultural Report in 1859; the second, by H. C. Beardslee, was published in 1874, and was reprinted in the Agricultural Report for 1879; and the third, by W. A. Kellerman and W. C. Werner, was included in the State Geological Report for 1893. This work contains a bibliography, and gives the names of the first known collectors of the less common species. A fourth catalogue, consisting of a check-list of the *Pteridophytes* and *Spermophytes*, recently published by Prof. W. A. Kellerman, contains the species and varieties numbered serially, as in the State Herbarium of nearly ten thousand sheets, with the sequence of groups as by Engler and Prantl, and the nomenclature as used by Britton and Brown.

NOTES.

The committee of the St. Petersburg Astronomical Society for the revision of the Russian calendar, to make it agree with the Gregorian, has found it necessary to move slowly. The festivals prove a formidable obstacle to the desired reform, and the people will have to be prepared for the change before it can be instituted. The plan now is to use both dates, Russian and Gregorian, together till the new style can be made familiar, and it is proposed to make the double use compulsory on private as well as on public documents and papers.

A steamboat company is placing its little vessels on the canals of Venice, and the gondolas, which were one of the charms of the city to travelers, are destined to disappear—unless a few may be reserved to gratify the curiosity of tourists.

The Commissioner of Education of Rhode Island has issued a circular to teachers, calling attention to the work of the Audubon Society for the Preservation of Birds, and to the incalculable value, from various points of view, of bird life, and advises them to foster Nature study as furnishing a natural channel by means of which instruction and information on the subject may readily be brought before the children, and through them to the people generally.

In a paper on The Ultimate Basis of Time Divisions in Geology, T. C. Chamberlin accepts it as proved that there were no universal breaks in sedimentation or in the fundamental continuity of life, no physical cataclysms attended by universal destruction of life, and that sedimentation has been in constant progress somewhere and life

continuous and self-derivative since the beginning. He then raises the question whether this continuity of physical and vital action proceeded by heterogeneous impulses or by correlated pulsations. The author's conclusion is in favor of the hypothesis of correlated pulsations involving a rhythmical periodicity.

Nettle fiber is said to be coming into great favor for the manufacture of fine yarns and tissues. Several factories in Germany are using it, and the introduction of the extensive cultivation of nettles into the African colony of the Cameroons is contemplated.

There are now, according to the last annual Report of the Commissioner of the General Land Office, thirty-six forest reservations (exclusive of the Afognak Forest and Fish-Culture Reserve in Alaska) in the United States, embracing an estimated area of 46,021,899 acres. This estimate is for the aggregate areas within the boundaries of the re[illegible]vations, but the lands reserved are [illegible]y the vacant public lands therein. The actual reserved area is therefore somewhat less than the estimate.

Experiments made by Professor Dewar and Sir W. Thisleton Dyer, and reported to the British Association, upon the effect of the temperature of liquid hydrogen upon the germinative power of seeds, go to show that life goes on at a temperature so low that ordinary chemical action is practically stopped. Seeds of barley, vegetable marrow, mustard, and the pea were immersed in liquid hydrogen for six hours, cooled to a temperature of 453° F. below the temperature of melting ice, and came out unchanged to the eye, and, when planted, all germinated.

Sir John Lubbock, having been raised to the peerage, has adopted Lord Avebury as his title, and will be henceforth so known.

In our obituary list of men known to science are the names of N. E. Green, F. R. A. S., who was distinguished for the excellence of his planetary observations, particularly of Mars, made at Madeira in 1877, and was the second President of the British Astronomical Association, died November 10th, in his seventy-sixth year; Prof. E. E. Hughes, inventor of the Hughes printing telegraph machine, the microphone, and the induction balance, Fellow of the Royal Society, gold medalist, and Chevalier of the Legion of Honor, who was born in London in 1831 and was brought to the United States at an early age; Mr. J. R. Gregory, mineralogist; M. Marion, professor in the Scientific Faculty in the University of Marseilles and Keeper of the Natural History Museum there, who took part in the dredging trips of the Travailleur and the Talisman, and contributed to the *Annales* of the museum at Marseilles; Dr. Hans Bruno Geinitz, geologist and paleontologist, at Dresden, Saxony, in his eighty-sixth year; Walter Götze, botanist, while on an expedition to German East Africa, December 9th; and Mr. W. T. Suffolk, treasurer of the Royal Microscopical Society of Great Britain.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins and Reports. Connecticut: Twenty-third Annual Report. Part I. Fertilizers. Pp. 92; Bulletin No. 130. Commercial Feeding Stuffs in the Connecticut Market.—North Dakota Weather and Crop Service, November, 1899, and January, 1900. Pp. 8 each.—United States Department of Agriculture: Agrostology Circular No. 54. Smooth Brome-Grass. Pp. 10; No. 57. Experiments with Forage Plants in Ontario. Pp. 3; Meteorological Chart of the Great Lakes. Summary for the Season of 1899. Vol. II, No. 9. By Alfred J. H. Henry and Norman B. Conger. Pp. 28, with maps.—West Virginia: Bulletin No. 61. Sheep-Feeding Experiments. By J. H. Stewart and Horace Atwood. Pp. 10; No. 62. A Study of the Effect of Incandescent Gaslight on Plant Growth. By L. C. Corbett. Pp. 38, with plates.

American Grocer Publishing Company. Scientific Testimony against the use of Alum in Food. (Evidence before the United States Senate Investigating Committee.) Pp. 12.

Andrews, William. The Diuturnal Theory of the Earth, or Nature's System of constructing a Stratified Physical World. New York: Myra Andrews

and Ernest G. Stevens, 18 West Forty-fifth Street.

Benson, Lawrence Sluter. Principles of Finite Values in Mathematics. Pp. 6.

Bland, Rev. J. P., Cambridge, Mass. What we Know about God. Pp. 12.

Bulletins, Reports, Announcements, etc. American Association for the Advancement of Science: Forty-eighth Annual Meeting, Columbus, Ohio, 1899. Proceedings. Pp. 527, with plates of portraits.—Annals of the Astronomical Observatory of Harvard College. Vol. XXXII, Part II. Visual Observations of the Moon and Planets. By W. H. Pickering, Director. Pp. 212, with plates; Vol. XXXIII. Miscellaneous Researches, 1897-1899. Pp. 287, with plates; Vol. XLII, Port II. Observations made at the Blue Hill Meteorological Observatory, Massachusetts, 1897 and 1898, under the Direction of A. Lawrence Rotch. Pp. 150.—Columbia University, New York: Summer Session, 1900. Announcement. Pp. 24.—Cuba, Department of Posts: Annual Report for the Fiscal Year ending June 30, 1899. Pp. 215.—Interstate Commerce Commission: Preliminary Report on the Income Account of Railways in the United States, to June 30, 1899. Pp. 70. —Massachusetts Institute of Technology, Boston: Annual Catalogue, 1899-1900. Pp. 357.—Michigan: Thirty-eighth Annual Report of the Secretary of the State Board of Agriculture, and Twelfth Annual Report of the Experiment Station. Pp. 465.—Missouri Botanical Garden: Twelfth Annual Report. By William Trelease. Pp. 151, with plates.—New York State: Report of the Committee on Canals, 1899. Pp. 231, with charts; Sixteenth Annual Report of the Bureau of Labor Statistics, 1898. Pp. 1179.—Perkins Institution and Massachusetts School for the Blind: Sixty-eighth Annual Report. Pp. 325. —United States Department of Labor: Bulletin No. 26. January, 1900. Pp. 236.—United States Geological Survey: Nineteenth Annual Report. Part V. Forest Reserves. Pp. 400, with portfolio of maps.

Burns, J. J. The Story of English Kings according to Shakespeare. New York: D. Appleton and Company. (Home-Reading Books.) Pp. 272.

Chambers, G. F. The Story of Eclipses. (Library of Useful Stories.) New York: D. Appleton and Company. Pp. 222, with plates. 40 cents.

Citator, The. Ohio Edition. (Register of Citations in Legal Practice.) Quarterly. Lapeer, Mich. Pp. 102.

Clinical Excerpts. Elberfeld Company, New York. Pp. 20.

Coulter, John M. Plant Structures. A Second Book of Botany. New York: D. Appleton and Company. (Twentieth Century Text-Books.) Pp. 348. $1.20.

Deniker, J. The Races of Men. An Outline of Anthropology and Ethnography. New York: Charles Scribner's Sons. (Contemporary Science Series.) Pp. 611. $1.50.

Echeveria i Reyes, Anibal. Voces Usadas en Chile. (Errors of Speech.) Santiago. Pp. 246.

Hannay, P. M. How to gain Health and Long Life. Chicago: The Hazel Pure-Food Company. Pp. 114.

I am that I am. A Dialogue of the Gods. By Sum quod Sum. New York: Library of Liberal Classics. Pp. 21. 10 cents.

Kent, Rev. Alexander. The Plan of Salvation. Pp. 16.

La Pouge, G. Vachet de. L'Aryen Son Role Social. (The Aryan, his Social Office.) Paris: Albert Fontemoing. Pp. 569. 10 francs.

Macmillan, The, Company. Announcements of New Books, Spring, 1900. Pp. 44.

McIlwraith, J. N. Canada. (History for Young Readers.) New York: D. Appleton and Company. Pp. 252.

Manning, Warren H. A Handbook for Planning and Planting Small Home Grounds. Stout Manual-Training School, Menomonee, Wis. Pp. 76.

Richter, Victor von. Organic Chemistry, or Chemistry of the Carbon Compounds. Edited by Prof. R. Anschütz and Dr. G. Schroeter. Authorized translation by Edgar F. Smith. Philadelphia: P. Blakiston's Son & Co. Pp. 671. $3.

Richardson, Harriet. A New Species of Idotea, from Hakodate Bay, Japan. Pp. 4.

Ward, Lester F. Description of a New Genus and Twenty New Species of Fossil Cycadean Trunks from the Jurassic of Wyoming. Pp. 32, with 7 plates.

Wooster, L. C. Educational Value of the Natural Sciences. Pp. 18.

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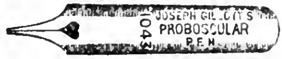

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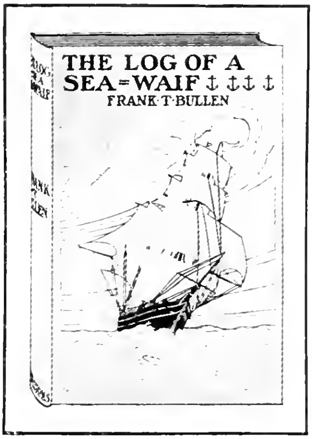

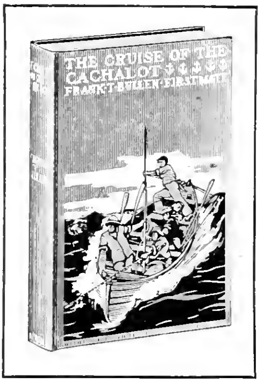

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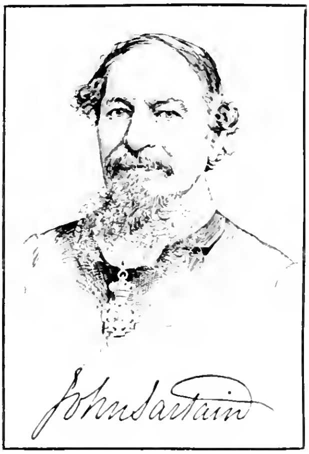

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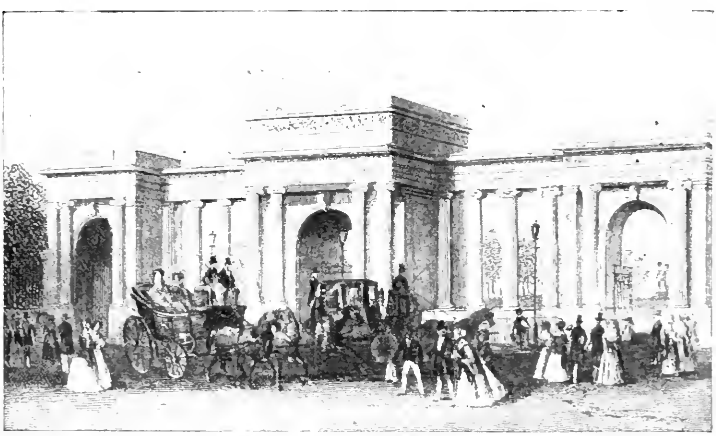

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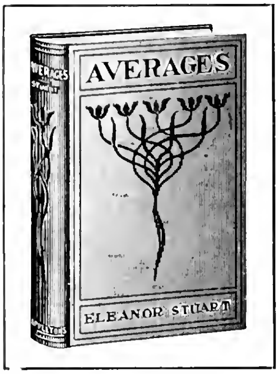

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THE AUTHOR'S LETTER.

SYRACUSE, N. Y., *December* 22, 1897.

I have taken the liberty of sending you by the American Express to-day the type-written manuscript of a story of American life which I have recently compiled, entitled "DAVID HARUM." I desire to submit this to you for examination, with a view to its publication, and trust you will find it suited to your requirements.

Very truly yours,

E. N. WESTCOTT.

E. N. WESTCOTT.

A LETTER FROM THE PUBLISHERS.

October 13, 1898—(Three weeks after publication).

To readers: Complaints have reached us this week of inability to obtain "DAVID HARUM."

While we should not have published this remarkable book unless we had believed in its success, we did not anticipate such prompt appreciation on the part of the reading public. Talk of editions has been cheapened by the indefiniteness of the term as it is commonly used, and we need only say that while the first printing of "DAVID HARUM" was as large as three of the "editions" sometimes referred to, our supply of the book was exhausted within two weeks after publication. We took steps to supply this deficiency immediately, and a new stock of "DAVID HARUM" will be ready on Saturday. A considerable part of this stock has been anticipated by back orders, but we shall use every effort to make the supply of "DAVID HARUM" equal to the demand hereafter. Such prompt appreciation of a new and unknown writer by critics and the reading public is a fact to be noted with satisfaction.

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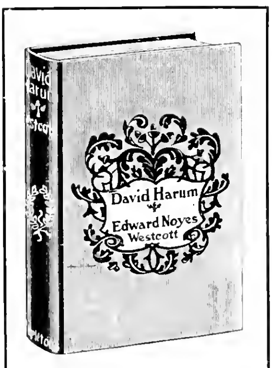

THE ENGLISH VERDICT.

LONDON, *September* 30, 1899.

"'DAVID HARUM' has at last 'caught on.' Until recently there has been little demand for it here. Undoubtedly the dialect in which so much of it is written was a stumbling-block to the English reader. But the merit of the book has told in spite of its dialect and the absence of any extensive advertising. Possibly the large number of Americans who have been in London during the last three months has had its effect in creating a demand for the book. When the bookstall keepers found that 'DAVID HARUM' was constantly called for by Americans, they decided that it was worth at least as prominent a place as they usually give to the works of Marie Corelli. At any rate, whatever the cause may be, the book is now undeniably a popular one, and its sales are constantly increasing."—William S. Alden, in New York Times Saturday Review.

The 330th thousand of "DAVID HARUM" is being printed on October 16th, when this page goes to press, and the orders show that this number must be increased before the printing of this page is finished.

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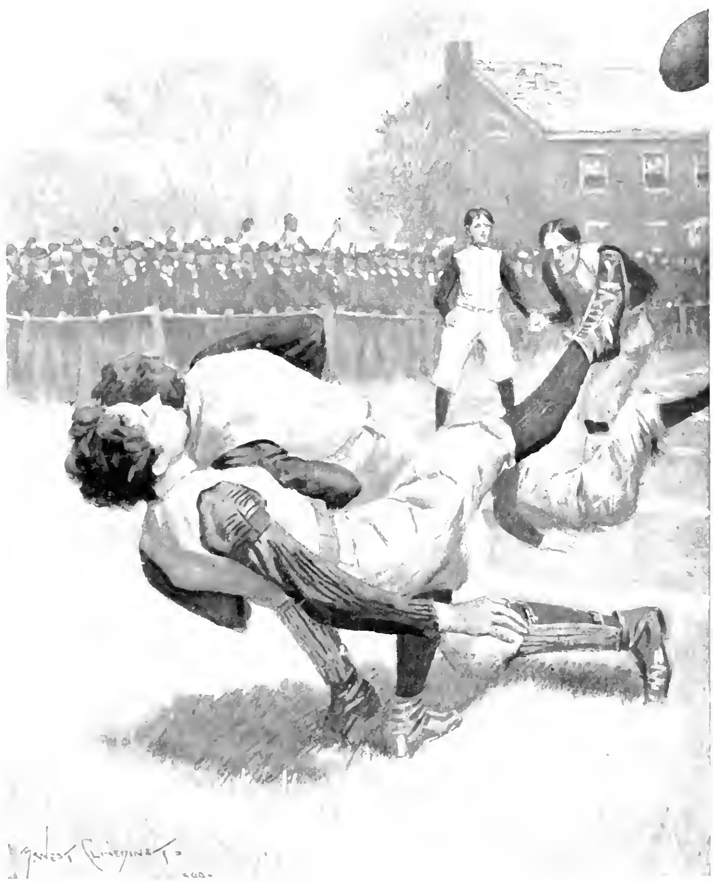

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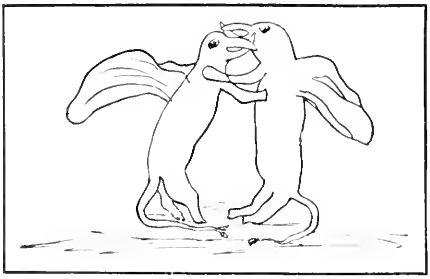

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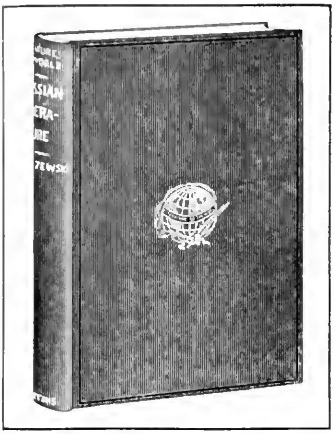

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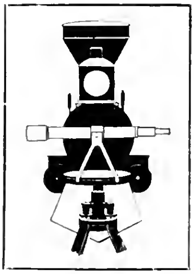

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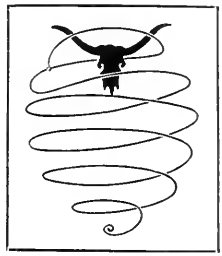

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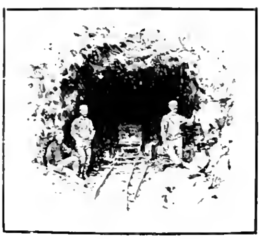

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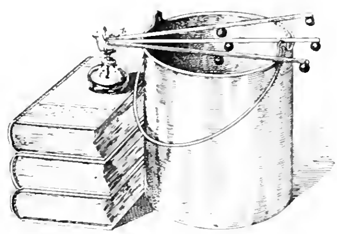

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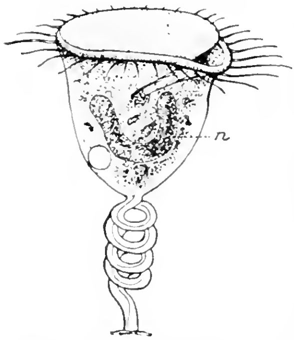

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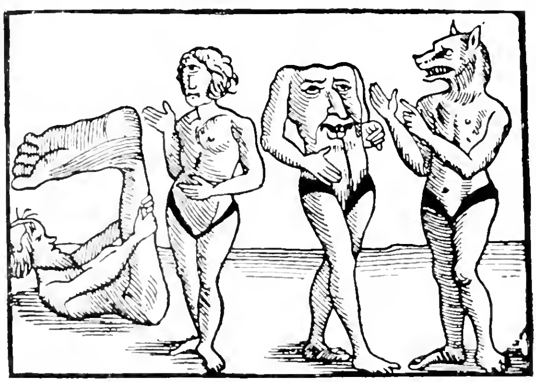
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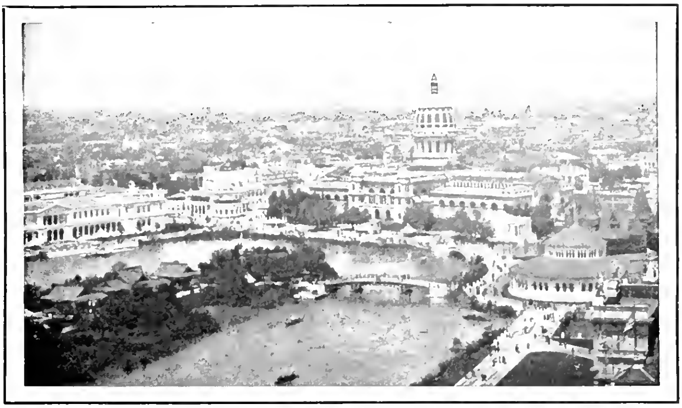

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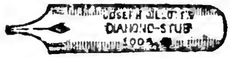

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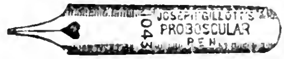

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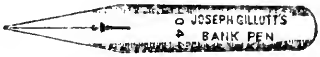

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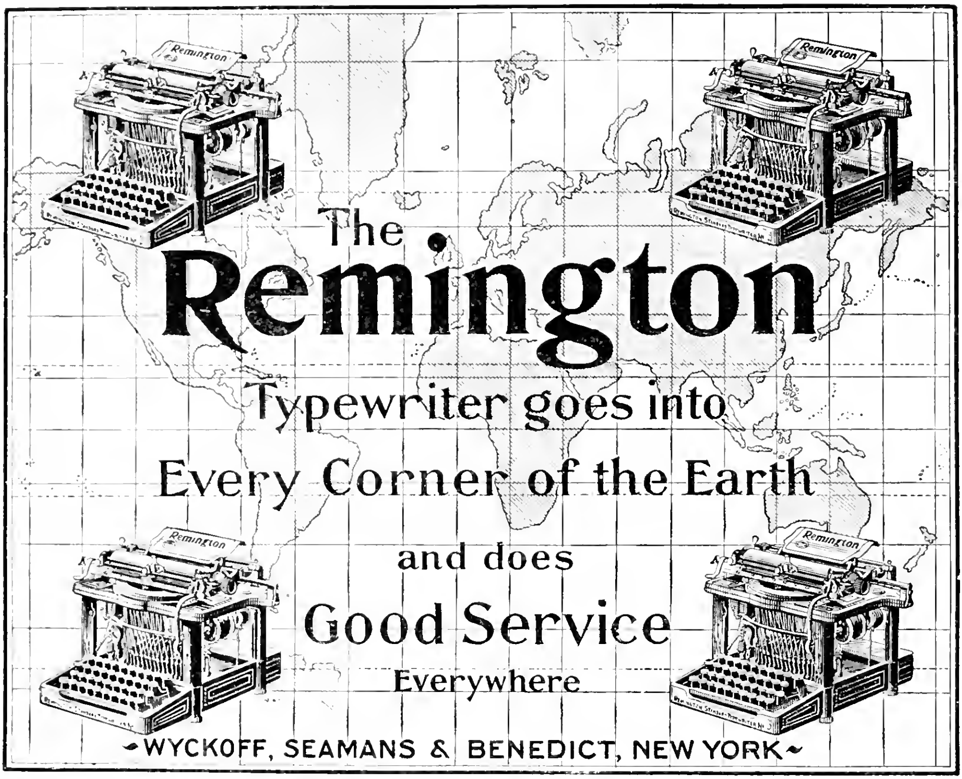

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PROSPECTUS FOR 1900.

FOR a magazine whose field has no limitations except those of science, it is quite impossible to make a comprehensive announcement of its contents a year ahead. Our purpose is primarily to keep its readers in touch with the most recent advances and discoveries as they are applicable to the promotion of human welfare and social progress. We believe that science is the force which has done the most in this direction in the past, and that it is what we must look to for growth in the future. We take advantage of every opportunity to secure articles that shall be entertaining as well as instructive without sacrificing accuracy, and we especially seek those authors who have the ability to write upon scientific subjects in a clear and instructive way.

The most characteristic feature of the nineteenth century, and especially of its latter half, has been the truly wonderful advance of science, both theoretical and practical. Coincident with this advance, and very largely dependent upon it, has been the unprecedented development of commerce and manufactures, of social organization and national wealth. A comparison of the potentiality of an unskilled laborer of one hundred years ago with that of a like workman of to-day brings out most strikingly what this scientific advance has accomplished in solving the problems of life and raising the standard of comfort; so that the luxuries of a few years ago are the necessities of to-day, and new pleasures have been added and even become common which were formerly beyond the reach of the wealthy. In view, then, of this prominently scientific aspect, the most

important and instructive portion of nineteenth-century history will be that of its scientific achievements, which, as Mr. Alfred Russel Wallace, the co-discoverer with Darwin of the great principle of natural selection, has pointed out in his "Wonderful Century," far exceed in number as well as in importance those of all the centuries that have preceded it.

A CENTURY OF SCIENCE.

No more appropriate and useful way of signalizing the completion of this century could be adopted than that of publishing during its closing year a history of its scientific work. In order to do this in the best manner, we have arranged for a series of articles on what has been accomplished in their several departments from leading authorities in their respective subjects—such as Sir Robert S. Ball in Astronomy; President Arthur T. Hadley in Economics; Prof. Joseph Le Conte in Geology; Prof. W. M. Flinders Petrie in Archæology; M. W. Haffkine in Preventive Inoculation; Prof. W. M. Davis in Meteorology; Prof. F. W. Clarke in Chemistry; and others of like standing in their specialties.

NEW DISCOVERIES AND INVENTIONS.

The Monthly will continue to give accounts of the course of discovery and of new developments in pure science; and careful writers familiar with their subjects will be engaged to describe whatever occurs in this field as soon as it has assumed definite form. Recognizing that the highest service that can be rendered by knowledge is in its use for the improvement of man's condition, special attention will be given to the adaptations of discovery to practical ends in the arts and industries, in the betterment of social life, and in the development of a wiser statesmanship for the administration of civil affairs.

THE PRACTICAL APPLICATIONS OF SCIENCE.

These are the tests by which science, and indeed any other like system, must be judged; and not only because the study of these applications is of value in leading to a general appreciation of the beautiful correlation between pure science and practical life, but more, perhaps, on account of the actual value of the information, we have always heretofore, and shall still more in the future, devote a certain portion of our space to their discussion. Among the earlier papers to appear will be a series of illustrated articles by William Baxter, Jr., C. E., explaining the theory of the trolley car and the mechanism on which its propulsion and control depend. In another department, to which much attention is now being given, Prof. C. E. Munroe, Dean of the Columbian University at Washington, whose long-continued

and exact researches in this subject have given him a world-wide reputation, will contribute some liberally illustrated articles on The Practical Applications of Explosives.

RECENT RESEARCH WITH THE X RAYS.

While much has been published about the wonderful qualities of the X rays and their capacity of adaptation to the wants of man, as yet but little is really known about them. The study of the phenomena is still going on, and is continually exhibiting new features and suggesting new objects on which they may be brought to bear. As a part of the record of these things, Professor Trowbridge, of Harvard University, will contribute an article describing some remarkable results of later investigations in the Lawrence Physical Laboratory, of which he is director.

THE RACE QUESTION.

The question of the adjustment of the relations of the races will be considered as offering some of the most serious and immediate difficulties our people have to confront, and one to which the thoughts of the best students of affairs are anxiously directed. Among the articles bearing upon this subject will be several by Prof. N. S. Shaler, of Harvard University, dealing with various aspects of the negro question. Professor Shaler spent his early life in the South, and knows the colored man well.

SCIENCE AND THE LAW.

Questions concerning methods of dealing with criminals will be discussed as of no less importance and equally fraught with dangers. The first article bearing on this subject, to be published in an early number, will be on the decline of our criminal jurisprudence, by a member of the New York bar. It will expose the urgent need of an infusion of scientific ideas into this exceedingly important branch of legal practice, and will present some facts illustrating the dangerous state into which it has fallen under the present antiquated systems.

CURIOSITIES OF NATURE.

No subjects more quickly and universally enlist attention or hold it longer than those of natural history. From the apparently inexhaustible store of novelties it affords, the curious blind fishes of North America—those remarkable products of retrograde evolution—are marked for early description in an article, accompanied by numerous illustrations, from the pen of Prof. Charles Eigenmann, who has made a special study of these fishes and is the acknowledged authority respecting them.

THE ADVANCE OF WOMAN.

Recognizing as one of the most striking social features of the life of the nineteenth century the enlargement of woman's sphere and the extension of her privileges, the Popular Science Monthly will endeavor to keep abreast of this movement. Among its most interesting recent phases is the advance in Germany, one of the latest countries to yield to it, but where women are now gradually making their way into the universities and active life. The history of this struggle and the degree of success which has been achieved there will be described in an early article of rare interest by Mary Mills Patrick, President of the American College for Girls at Constantinople.

COLONIAL QUESTIONS.

The important political questions arising through our recent acquisition of outlying territory will receive considerable attention. Two articles which will appear in early numbers, under the title Colonies and the Mother Country, take up the question of their proper relations.

MORALS AND EXPEDIENCY.

The drink evil, and vivisection, two of the most pressing moral questions now engaging the attention of society, are scheduled for early treatment; and we have already arranged for several articles taking up important questions connected with modern religious tendencies.

EDUCATION.

Of equal importance with all these branches of knowledge, and an essential prerequisite to receiving and rendering them available for use, is education. The Monthly has in the past given this subject prominent attention and preference, and will continue to do so. We have always aimed to make the articles in this field not only of general philosophical interest, but more especially to select subjects and modes of treatment which should be suggestive and practically valuable to the working teacher.

The North American Review for 1900

THOSE who have followed the course of THE NORTH AMERICAN REVIEW since it came under the present management in May of this year need not be told what they may confidently expect to find within its covers during the coming year. It is due, however, to the many thousands into whose hands this circular will come as a first indication of the purposes and accomplishments of the magazine, to afford, as nearly as may be, the same basis of expectation.

Following is a partial list of the articles which have appeared in the REVIEW during the past seven months:

POETRY

A Channel Passage—1855, ALGERNON CHARLES SWINBURNE

Hawthorn and Lavender—Songs and Madrigals, W. E. HENLEY

"A Carol of Birds" and Other Poems, NORA HOPPER

LITERATURE

The New Poetry, WILLIAM DEAN HOWELLS

The Present Literary Situation in France. HENRY JAMES

Girls' Novels in France, YETTA BLAZE DE BURY

The Pleasures of Poverty, MAX O'RELL

The Story of a Helpful Queen, CARMEN SYLVA

The Literary Movement in Ireland, W. B. YEATS

ART

The Tercentenary of Velasquez, CHARLES WHIBLEY

A Century of Salons, ELIZABETH ROBINS PENNELL

The Picture Gallery of the Hermitage, CLAUDE PHILLIPS

SCIENTIFIC

Wireless Telegraphy, G. MARCONI

Its Scientific History and Uses, Prof. J. A. FLEMING

Automobilism in France, MARQUIS DE CHASSELOUP-LAUBAT

THE DRAMA

The Dramatic Festivals of Orange, JULES CLARETIE

Censorship of the Stage in England, G. BERNARD SHAW

RELIGIOUS

The Practice of Confession in the Catholic Church, The Rev. R. F. CLARKE, S. J.

The Agnostic's Side, ROBERT G. INGERSOLL

Ingersoll's Influence, Rev. Dr. HENRY M. FIELD

The Zionist Movement, Prof. RICHARD GOTTHEIL

The Religious Situation in England, IAN MACLAREN

The Rebellion against the Royal Supremacy, THE EARL OF PORTSMOUTH

How the Ritualists Harm the Church, The Rt. Hon. ARTHUR J. BALFOUR

"Americanism," True and False, Rev. Dr. WILLIAM BARRY

EDUCATIONAL

Commercial Education, The Rt. Hon. JAMES BRYCE, M.P.

The Curse in Education, REBECCA HARDING DAVIS

Our Public Schools, M. G. VAN RENSSELAER

American Universities, EDOUARD ROD

WOMEN

The Woman's International Parliament, ... THE COUNTESS OF ABERDEEN
. . . . KASSANDRA VIVARIA

The Reverses of Britomart, EDMUND GOSSE

East Indian Women, Mrs. F. A. STEEL

INTERNATIONAL TOPICS

Arbitration and the Conference at The Hague:
- From an American Standpoint, SETH LOW
- The Moral Aspect of War, Capt. A. T. MAHAN
- A Russian View, F. DE MARTENS
- In the Clutch of the Harpy Powers, R. M. JOHNSTON
- Universal Peace, Baroness BERTHA VON SÜTTNER

The Peace Conference: Its Possible Practical Results, A DIPLOMATIST AT THE HAGUE

China and the Powers, Lord CHARLES BERESFORD

The Imbroglio in Samoa, HENRY C. IDE

A Plea for a Russo-American Understanding, Prince E. OOKHTOMSKY, VLADIMIR HOLMSTREM

Ex Oriente Lux—A Rejoinder, ARCHIBALD LITTLE

America and England in the Far East, The Rt. Hon. Sir CHARLES DILKE

The Alaskan Boundary, Prof. J. B. MOORE

Work of the Joint High Commission, A CANADIAN LIBERAL

THE WAR IN SOUTH AFRICA

Historical Causes of the War, The Rt. Hon. JAMES BRYCE, M.P.
(With a Colored Map of Seat of War.)

The War and European Opinion, KARL BLIND

Philosophy and Morals of War, MAX NORDAU

England and the Transvaal, SYDNEY BROOKS

Will the Powers Intervene? FRANCIS CHARMES

The South African Question, ANDREW CARNEGIE

A Possible Anti-British Alliance, DEMETRIUS C. BOULGER

A Transvaal View, Dr. F. V. ENGELENBURG

A Vindication of the Boers, A DIPLOMAT

AMERICAN AND POLITICAL

The War with Spain, Major-General NELSON A. MILES

The Foreign Service of the United States, FRANCIS B. LOOMIS

Aguinaldo's Case against the United States, A FILIPINO

The Paramount Power of the Pacific, JOHN BARRETT

The Logic of Our Position in Cuba, AN ARMY OFFICER

Jeffersonian Principles, WILLIAM J. BRYAN

What Spain Can Teach America, NICOLAS ESTEVANEZ

The Nicaragua Canal, THOMAS B. REED

Conditions and Needs in Cuba, Major-General LEONARD WOOD

The "Open Door" in the Philippines, FRANK D. PAVEY

Is Civil Service Reform in Peril? Prof. J. F. JOHNSON

A Trained Colonial Civil Service, E. G. BOURNE

The Restless Energy of the American People, IAN MACLAREN

The Fifty-sixth Congress:
- Has Congress Abdicated? JOSEPH PULITZER
- Congress, the President and the Philippines, PERRY BELMONT
- Securing the Gold Standard by Law, JOHN DALZELL

FOREIGN

France at the Parting of the Ways, BERNARD LAZARE

The French Press and the Dreyfus Case, M. DE BLOWITZ

Japan's Entry into the Family of Nations, T. R. JERNIGAN

The Outlook for Carlism, The Hon. JAMES ROCHE, M.P.

England in Egypt and the Soudan, Col. CHARLES CHAILLÉ LONG

Present Aspects of the Dreyfus Case, JOSEPH REINACH

COMMERCIAL AND FINANCIAL

Condition and Needs of the Treasury, LYMAN J. GAGE

Anti-Trust Legislation, Gov. JOSEPH D. SAYERS

Legal Aspect of Trusts, JOSEPH S. AUERBACH

Pig Iron and Prosperity, GEORGE H. HULL

The Industrial Commission, S. N. D. NORTH

The Decline of British Commerce, A. MAURICE LOW

Five Years of American Progress, M. G. MULHALL

GENERAL

Israel Among the Nations, MAX NORDAU

Social Tendencies in America, Bishop HENRY C. POTTER

The Case against Christian Science, W. A. PURRINGTON

Taxation of Public Franchises, Senator JOHN FORD

Some Consecrated Fallacies, AMOS K. FISKE

Courts-Martial in England and America, The Rt. Hon. Sir F. H. JEUNE

Athletics for Politicians, Rt. Hon. Sir CHARLES W. DILKE, Bt., M.P.

Food Which Fails to Feed, LOUIS WINDMÜLLER

The Government of New York, Comptroller BIRD S. COLER

The "America" Cup Race, Hon. CHARLES RUSSELL

Golf from a St. Andrew's Point of View, ANDREW LANG

The Highways of the People, HUGH H. LUSK

After the Yacht Race, Sir THOMAS LIPTON

Constitutional Conflict in Finland, A MEMBER OF THE FINNISH DIET

Vol. LVI.] Established by Edward L. Youmans. [No. 4.

APPLETONS' POPULAR SCIENCE MONTHLY.

EDITED BY WILLIAM JAY YOUMANS.

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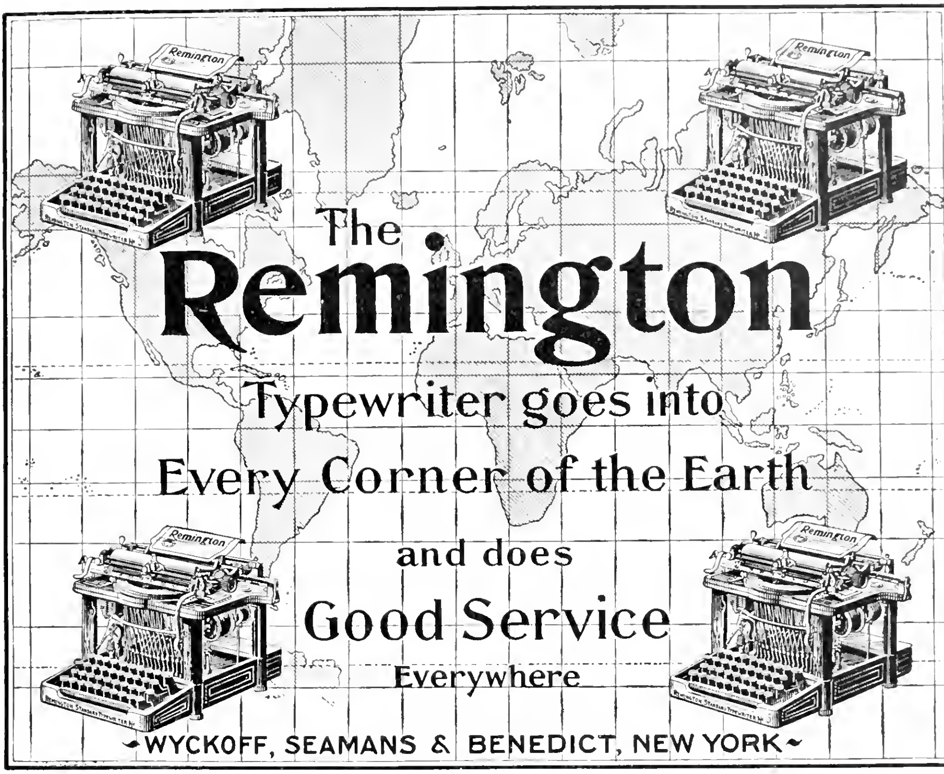
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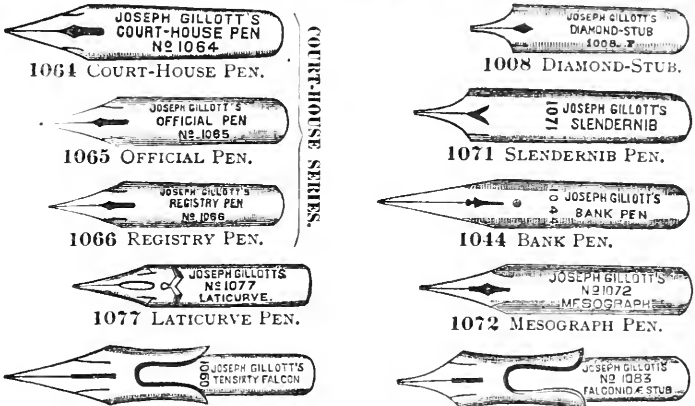

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EDITED BY WILLIAM JAY YOUMANS.

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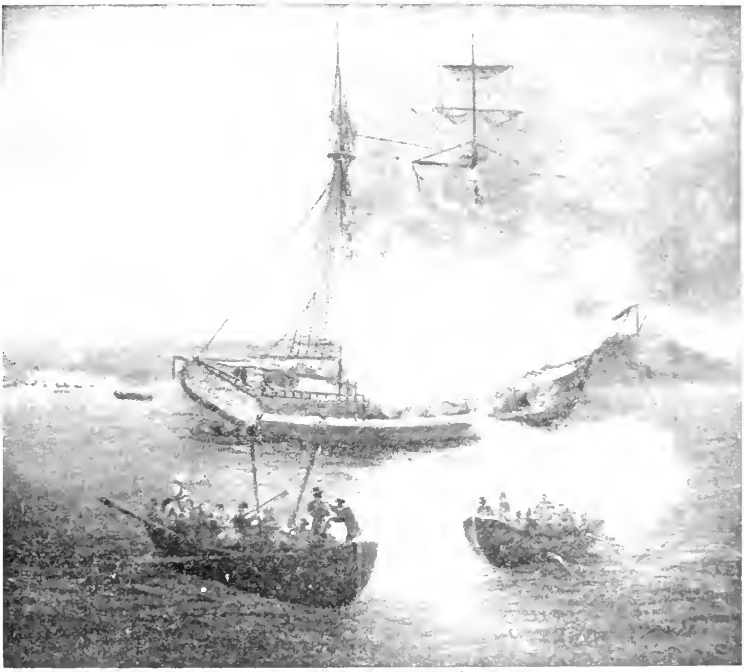

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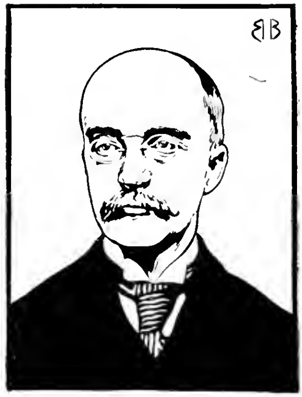
In the introduction to his delightful and suggestive book Mr. Chapman writes of the charm of bird photography as follows: "As a one-time sportsman, who yielded to none in his enjoyment of the chase, I can affirm that there is a fascination about the hunting of wild animals with a camera as far ahead of the pleasure to be derived from their pursuit with shotgun or rifle as the sport found in shooting quail is beyond that of shooting clay pigeons. Continuing the comparison from a sportsman's standpoint, hunting with a camera is the highest development of man's inherent love of the chase. The killing of a bird with a gun seems little short of murder after one has attempted to capture its image with a lens. The demands on the skill and patience of the bird photographer are endless, and his pleasure is intensified in proportion to the nature of the difficulties to be overcome, and in the event of success it is perpetuated by the infinitely more satisfactory results obtained. He does not rejoice over a bag of mutilated flesh and feathers, but in the possession of a trophy—an eloquent token of his prowess as a hunter, a talisman which holds the power of revivifying the circumstances attending its acquisition. What mental vision of falling birds can be as potent as the actual picture of living birds in their homes? And how immeasurably one's memories are brightened by the fact that this is not a picture of what has been, but of what is! The camera thus opens the door to a field of sport previously

closed to those who love birds too much to find pleasure in killing them ; to whom Bob-White's ringing whistle does not give rise to murderous speculations as to the number in his family, but to an echo of the season's joy which his note voices. They therefore have a new incentive to take them out of doors ; for however much we love Nature for Nature's sake, there are few of us whose pleasure in an outing is not intensified by securing some definite, lasting result."



JOHN BACH McMASTER.

In the fifth volume of his *History of the People of the United States* Professor McMaster deals with a period of our history between 1821 and 1830, which in many of its phases has received but scant attention. The close of Monroe's term, the administration of John Quincy Adams, and the stormy opening years of Jackson, form an epoch of peculiar interest in view of the development of the democratic spirit, the manifestations of a new interest in social problems, the experiments in banking and finance, the improvements in the conditions of city life, the changing relations between the East and West, and the author's full and striking presentation of the literary activity of the country at that time.

Professor McMaster's volume opens with a chapter on the Early Settlement of Texas by Austin and his imitators, and on the origin and first temporary settlement of the Oregon dispute by the establishment of the line 54° 40′. It was in connection with this line that Adams announced to Russia the anticolonization part of the Monroe Doctrine.

The second chapter, therefore, under the caption Growth of the Monroe Doctrine, reviews the gradual development and assertions of the three principles of that doctrine from Washington's day to 1823 ; the Holy Allies and their work in Europe, their preparation for interference with the late Spanish-American colonies, and the final assertion of the doctrine of Monroe. After thus reviewing the important foreign relations of Monroe's second term, Mr. McMaster returns to domestic concerns, and in the next chapter treats of The Breaking Up of the Republican Party. The economic, industrial, and political conditions which led to sectionalism, the rise of the rival candidates, and the long presidential campaign ending in the failure of the colleges to elect, are given with great fullness.

The election of Adams marked the end of the first half century of the republic. The next eight chapters are therefore given up to an examination or review of certain social, political, literary, and industrial conditions which arose during the period and paved the way for the triumph of Jackson and Democracy.

In the chapter on Socialistic and Labor Reforms we have the story of the entrance of the workingman into politics ; of that curious socialistic movement of

Owen and Fanny Wright; the beginning of the Antimasonic party, and the early signs of native Americanism.

The next chapter is a full account of The State of the Country from 1825 to 1829; the rapid growth of cities; early problems in city government; the introduction of gas and anthracite coal; the opening of the Erie Canal and the tremendous struggle for Western trade, etc. Following this is a chapter on The Negro Problem; and the next chapter, under the title The Industrial Revolution, is an account of the rise and development of manufactures; of the conditions which led to the tariffs of 1824 and 1828; their peculiar characters; the violent opposition of the South, and assertions of the State-Rights Doctrine of Calhoun and his party.

This is followed by an account of our early literary efforts which is singularly fresh, informing, and interesting. There is a chapter on The Common Schools during the first half century, and another, quite timely now, on British Criticism of the United States, setting forth very fully why our fathers hated Great Britain so heartily. Then follows an elaborate review of Political Ideas; a chapter on foreign complications; the Panama Congress; the prevention of the independence of Cuba by the United States in the interest of the slaveholding States; the Maine boundary dispute with Great Britain; the Oregon agreement of 1827; and, finally, a chapter on The Triumph of Democracy, detailing the famous struggle ending in the election of Jackson, the removals from office, and the attempt to buy Texas.

DAVID A. WELLS.

In the introduction to his *Principles of Taxation* the late Dr. Wells wrote: "It is the purpose of the writer, in the chapters which follow, to discuss the principles of taxation from a broader basis and by different methods than have heretofore been attempted, special consideration being given to the experience of the United States. Such a discussion primarily involves the inquiry, of how far the varied and curious experience of nations leads up through what may be regarded as a process of evolution, to a recognition of the underlying and essential principles of a just and at the same time an efficient system of taxation. And it also necessitates, for the attainment of correct conclusions in the prosecution of such inquiry, that illustrations drawn from the world's great record of experience should take precedence of theory, especially in the way of example and exhibit of the many abuses of the power of taxation which the ignorance of legislators and the cupidity of designing men have inflicted upon nations.

"There can be no civilization without government, and no government without an adequate supply of revenue obtained from the persons and property of the people governed. There can be no health in the body politic without sound

finance, and no sound finance without a sound system of taxation. In fact, taxation is to our body politic what blood is to the body physical: if healthy, infusing life and warmth; but if unhealthy, the agent for producing discontent, decrepitude, and paralysis.

"The absence or existence of limitations on the power of a government to make compulsory levies on the property or persons of its people for its use or support, constitutes the dividing line between a despotism and a free government —a fact most pertinent to legal, economic, and societary studies which has attracted little attention.

"The methods and scope of what is called taxation regulate more than all other agencies the distribution of wealth, which is really the great question of the future to all nations."

N. S. SHALER.

The lucidity and suggestiveness of Prof. N. S. Shaler's writings, whether they are expositions of scientific themes or discussions which touch upon sociological topics, will induce readers to await with especial interest his forthcoming book, *The Individual: A Study of Life and Death*, which is a striking and noble presentation of the subject of death from a fresh point of view. Professor Shaler's book is one of deep and permanent interest. He points out that while the problems of natural selection and evolution have called attention to the results which come from the temporary quality of the individual, they have not heretofore led to any extended interest in the relation of the ephemeral nature of the individual to the other individualities of the universe and to the method of its organization. In his preface he writes as follows: "In the following chapters I propose to approach the question of death from a point of view of its natural history, noting, in the first place, how the higher organic individuals are related to those of the lower inorganic realm of the universe. Then, taking up the organic series, I shall trace the progressive steps in the perfection of death by a determination as to the length of the individual life and its division into its several stages from the time when the body of the individual is separated from the general body of the ancestral life to that when it returns to the common store of the earth. Upon the basis of the knowledge we may thus obtain, I shall endeavor to see what qualifications of the accepted view of the great accident we may make—how, in a word, we may hope to work toward a reconciliation of our death with the order in which we find ourselves placed. . . . In effect this book is a plea for an education as regards the place of the individual life in the whole of Nature which shall be consistent with what we know of the universe. It is a plea for an understanding of the relations of the person with the realm which is, in the fullest sense, his own; with his fellow-beings of all degrees which are his kinsmen; with the past and

the future of which he is an integral part. It is a protest against the idea, bred of many natural misconceptions, that a human being is something apart from its fellows; that it is born into the world and dies out of it into the loneliness of a supernatural realm. It is this sense of isolation which, more than all else, is the curse of life and the sting of death."

Appletons' World Series, the new Geographical Library edited by H. J. Mackinder, M. A., Reader in the University of Oxford, will consist of twelve volumes. Each volume will describe a great natural region, its marked physical features, and the life of its people. Together the volumes will give a complete account of the world, more especially as the field of human activity. The series is intended for reading rather than for reference, and will stand removed on the one hand from the monumental work of Reclus, and on the other from the ordinary text-book, gazetteer, and compendium. In their presentation of the facts the authors will study above all things *perspective*, and will seek to convey right proportions rather than statistical accuracy. Facts will not be presented merely as facts, but always in their causal or graphic relations. Thus, each volume will give a succession of vivid ideas, to be grasped pictorially, and to remain in the memory. The reader will be led to visualize a great relief model in color, with its seas and its lands, its uplands and its lowlands, its rivers and their valleys, its forests and deserts, and its seasonal changes. Above all, he will think of it as the stage of human action, and will realize the relations of man—and especially of his economic and political organizations—to the grand features of physical geography. Care will be taken to tell the results of natural and economic science in language devoid of technicality, and to make each of the books interesting and attractive to every reader, although a solid contribution to geographical literature. The series will appeal to teachers, to students, to tourists, to business men, and to the general reader. The teacher will find suggestions for salient points in his teaching; the general reader will learn the persistent factors controlling the passing events chronicled in the newspapers; the tourist will grasp the real working of the community he visits, and not merely its curiosities and antiquities; and the merchant will realize the varied circumstances of his markets. Each volume is to be illustrated by many maps printed in colors and by diagrams in the text; and it will be a distinguishing characteristic of the series that both maps and diagrams will be drawn so that each of them shall convey some salient idea, and that together they shall constitute a clear epitome of the writer's argument. With a like object the pictures also will be chosen so as to illustrate the text, and not merely to decorate it. When possible, the books will be written from the point of view of the region described, and every effort will be made to avoid bias, patriotic or other.

The Brass Bottle, the forthcoming romance by F. Anstey, the brilliant author of "Vice Versa" and "The Tinted Venus," shows the author in his happiest vein. The story is an imaginative romance full of quaint conceits and deliciously

extravagant situations. His new book is the most important, as regards length, quality, and sustained interest, which he has given us for some time. The scene opens in London with the introduction of a struggling architect to whom there comes an extraordinary experience which furnishes a fair field for the fancy and humor of the writer. There can be no doubt regarding the popularity of Mr. Anstey's latest novel.

The author of *The Girl at the Halfway House*, Mr. E. Hough, gained general recognition by his remarkable book, "The Story of the Cowboy," published by D. Appleton and Company in this country, and also published in England.

E. HOUGH.

The Girl at the Halfway House has been called an American epic by critics who have read the manuscript. The author illustrates the strange life of the great westward movement which became so marked in this country after the civil war. A dramatic picture of the battle of Fredericksburg, which has been compared to scenes in "The Red Badge of Courage," opens the story. After this "Day of War," in which the hero and heroine first meet, there comes "The Day of the Buffalo." The reader follows the course of the hero and his friend, a picturesque old army veteran, to the frontier, then found on the Western plains. The author, than whom no one can speak with fuller knowledge, pictures the cowboy on his native range, the wild life of the buffalo hunters, the coming of the white-topped emigrant wagons, and the strange days of the early land booms. Into this new world comes the heroine, whose family finally settles near at hand, illustrating the curious phases of the formation of a prairie home. The third part of the story, called "The Day of the Cattle," sketches the wild days when the range cattle covered the plains and the cowboys owned the towns. The fourth part of the story is called "The Day of the Plow," and in this we find that the buffalo has passed from the adopted country of hero and heroine, and the era of towns and land booms has begun. While this story is a novel with a love motive, it is perhaps most striking as a romance of the picturesque and dramatic days of early Western life. It shows the movement westward, and the free play of primitive forces in the opening of a new country. Nothing has been written on the opening of the West to excel this romance in epic quality, and its historic interest, as well as its freshness, vividness, and absorbing interest, should appeal to every American reader.

The Last Lady of Mulberry is the title of a fresh and charming novel, whose author, a new writer, Mr. Henry Wilton Thomas, has found an unexploited field in the Italian quarter of New York. Mr. Thomas is familiar with Italy as well as New York, and the local color of his vivacious pictures gives his story a

peculiar zest. As a story pure and simple his novel is distinguished by originality in motive, by a succession of striking and dramatic scenes, and by an understanding of the motives of the characters, and a justness and sympathy in their presentation which imparts a constant glow of human interest to the tale. The author has a quaint and delightful humor which will be relished by every reader. While his story deals with actualities, it is neither depressing nor unpleasantly realistic, like many "stories of low life," and the reader gains a vivid impression of the sunnier aspects of life in the Italian quarter. The book will contain a series of well-studied and effective illustrations by Mr. Emil Pollak. In order to obtain accurate material for the illustrations the artist and author together have visited the scenes of the novel in the neighborhood of Mulberry Park, formerly known as Mulberry Bend, where they obtained photographs and sketches which Mr. Pollak has consulted judiciously with a view to the interpretation of the actual atmosphere of the scenes described.

Three years ago a brilliant and already distinguished clergyman, then of Boston, published "A Hero in Homespun," a romance of unknown types and phases of life in the mountains of Tennessee and Kentucky during the civil war. The success of this fresh and vigorous romance, of which a new edition is to be published by D. Appleton and Company, has not induced the author, Dr. William E. Barton, to sacrifice anything to hasty production. He has written no other novel until the present time, when Messrs. D. Appleton and Company are able to announce his new romance, *Pine Knot, a Story of Kentucky Life*, which will appear in April. Dr. Barton was born in Sublette, Illinois, where he spent his first twenty years, but he gained his knowledge of the mountain folk of Kentucky and Tennessee by immediate association, first as a student at Berea College in Kentucky and afterward as a missionary in the mountains, and later as a visitor and traveler through the most unfrequented parts. Another journey in the mountains was made especially in the interests of *Pine Knot*. The story is full of the atmosphere of the quaint mountain life with its wealth of amusing peculiarities, and it also has a historical value, since it pictures conditions attendant upon the antislavery movement and the days of the war. The interest of a treasure search runs through the tale, since the author has adroitly utilized a mountain legend of a lost mine. *Pine Knot* is a romance "racy of the soil" in a true sense, a story fresh, strong, and absorbing in its interest throughout. Of the scenes of this novel the author has said: "A region so beautiful in its scenery and romantic in its traditions as that which surrounds the Falls of the Cumberland River deserves to be represented in literature. The plan of a story embodying these traditions and dealing with the lives of the people in the heroic period of their history has been maturing in my mind for many years, during which time material for the work has been accumulating. The legend of the Swift Silver Mine is in itself so interesting as to require little shaping at the hands of the story-teller; and the scheme for its development just before the war, with the brilliant visions of enormous wealth and the result, are matters of record."

J. A. ALTSHELER.

Mr. J. A. Altsheler has earned a reputation by his novels of the French Wars, the Revolution, and the War of 1812, and in his new romance, to which he has devoted himself for a long time, he tells a thrilling story of the civil war. The scene opens in Washington just before the arrival of Lincoln, whose coming and inauguration are graphically described. Later in the story the leading characters are reunited in the South, and the love story with its dramatic interruptions and suspended interest runs through the book. There are vivid pictures of Shiloh and Gettysburg, with adventures inside the Confederate lines. In this strong, well-studied, and absorbing romance the author has produced his most important work. The title of Mr. Altsheler's new romance may be changed, but its present name is *In Circling Camps*.

Mirry-Ann, a Manx story, by Norma Lorimer, is a quaint and charming novel of life in the Isle of Man, by a writer new to American readers. It is a love story rather than a drama, although there are dramatic episodes. The local color of the scene is cleverly suggested but not insisted upon, and the tale is one of universal interest, excellent in its characterization and contrasts of types, entertaining in its humorous by-play, thoroughly sympathetic and full of interest from the first page to the last.

ANNA ROBESON BROWN.

In *The Immortal Garland*, a striking novel of American life, by Anna Robeson Brown, the author develops contrasting careers which have to do with literature, the stage, and society. Her treatment of her theme is vigorous and effective, and no reader of the book will fail to feel the actuality of her characters and the logic of their development. The action of the novel passes largely in New York. The story abounds in vivid pictures and well-realized situations, and the phases of American life which it depicts are presented with a vigor and power of graphic delineation which will arrest attention and gain for this strong novel a high place among contemporary American fiction.

In *A History of American Privateers*, Mr. Edgar Stanton Maclay, the distinguished historian of American sea power, presents the first comprehensive account of one of the most picturesque and absorbing phases of our maritime war-

EDGAR S. MACLAY.

fare. The intimate connection between privateers and the navy, the former serving often as a training school for the latter, is brought out in the author's narrative. From forgotten monographs, the records of societies, from unpublished log books, and from descendants of noted privateersmen, he has obtained intimate and vivid accounts of the fitting out of the vessels, the incidents of their voyages, and the thrilling adventures of the brave sailors who manned them. Samuel Reid's desperate fight at Fayal is well known, but he was only one of many who shared in adventures not dissimilar and faced overwhelming odds with the splendid courage characteristic of American sailors. Mr. Maclay's romantic tale is accompanied by reproductions of contemporary pictures, portraits, and documents, and also by illustrations by Mr. George Gibbs. In his preface Mr. Maclay says: "The history of the United States Navy is so intimately connected with that of our privateers that the story of one would be incomplete without a full record of the other. In each of our wars with Great Britain many of the captains in the navy assumed command of privateers in which they frequently rendered services of national importance, while the privateersmen furnished the navy with a large number of officers, many of whom became famous. In our struggle for independence more than sixty American privateers were commanded by men who had been, or soon became, officers in the regular service, and in more than one instance—notably that of the officers and men of the Ranger, Captain John Paul Jones's famous ship, then commanded by Captain William Simpson—almost the entire ship's company of a Continental cruiser turned to privateering. Many of our most distinguished navy officers have pointed with pride to their probationary career in privateers. The mere mention of such names as Truxtun, Porter, Biddle, Decatur, Barney, Talbot, Barry, Perry, Murray, Rodgers, Cassin, Little, Robinson, Smith, and Hopkins will show how closely related were the two arms of our maritime service." Widespread popularity for this volume and appreciation of its high merit have already been shown. The Philadelphia *Public Ledger* says, "Every chapter is crowded with incident and adventure that it would be difficult for the novelist to surpass in variety and invention;" while the characterization of the Chicago *Evening Post* is, "From beginning to end it is as interesting as a novel." Perhaps the wide range of readers to which this book is adapted is best indicated by the comment of *The Churchman:* "It is hard to see what American this book could fail to interest, from the admiral to the schoolboy."

The White Terror, by Felix Gras, has had the same enthusiastic reception which was given to this popular French author's other romances, "The Reds of the Midi" and "The Terror." When "The Reds of the Midi" was

FÉLIX GRAS.

published by the Messrs. Appleton, Félix Gras was unknown outside of France. In the Midi he had gained recognition as a poet and writer of stories, and he had been chosen as the head of the Felibrige, that society of romancers and singers of which Mistral and Roumanille were the earlier chiefs. With the appearance of "The Reds of the Midi," however, it was made clear to America and to England that a new light had appeared in modern literature. The simplicity, fervor, vividness, and dramatic force of this romancer of the Midi drew words of unstinted praise from critics and readers, and even Gladstone paused in his labors to read the book and eulogize the author. "The Reds of the Midi" was followed by "The Terror," another success; and the author now offers in *The White Terror* the concluding volume of his great trilogy of the French Revolution, which with its splendidly sustained interest, its vitality, and its swift, strong current of action, comes as the crown of the author's interpretation of the Revolution in fiction. Added to the charms of graphic and often poetic style, keen appreciation of dramatic effects, and rare power of individualization, his earnestness of conviction and purpose gives an exceptional value to his stories. He writes because he has something in his heart to say, and his fervid republican and patriotic feeling is constantly demonstrated. Himself a Provençal, it is natural that he should have chosen for his field of historical romance the south of France, and every chapter of *The White Terror* shows thorough knowledge of the country and its people, keen appreciation of their noble virtues and ferocious vices.

Mr. Richard H. Titherington's *History of the Spanish-American War* is a carefully compiled, comprehensive, and rigidly impartial historic account of the causes leading to our war with Spain, the war itself, and circumstances incident to the termination thereof. It is to be noted that the author has awaited the official reports on both sides, and he is therefore able to present a well-founded and authoritative history. Omitting no detail possessing real importance, it is necessarily concise, and no space is wasted in descriptive "fine writing" or extended critical disquisitions. As an authoritative work for reference it will be found of exceptional merit, and its value is materially enhanced by many excellent sketch maps and a very thorough index. The long story of Spanish misgovernment and Cuban revolt, down to the climax of outrage and suffering under Weyler's rule, is all compressed into the first fifty pages; an exhaustive and accurate comparison of the resources of Spain and the United States only takes up eighteen pages; and eight pages suffice for the narration of Admiral

Dewey's marvelous victory in Manila Bay. Yet nothing of moment is neglected, or even treated in a manner suggestive of insufficiency. Events that have been subjects of serious contention and citation of authorities for the fixing of grave responsibility are dealt with more *in extenso*, as, for instance, the discovery and destruction of Cervera's fleet, the inadequacy of our commissary department, as shown at Santiago, the evil conditions of our hospital transports, and our relations to the Philippine insurgents.

Prof. G. Maspero's latest volume, *The Passing of the Empires (Egypt, Assyria, Babylonia, Persia, and Medea)*, 850 B. C. to 330 B. C., brings the history of Egypt, Assyria, Babylonia, Persia, and Medea down to the victories of Alexander the Great, and completes this historian's remarkable series, which has been called "the greatest and most scholarly work on the history of the ancient world." The London *Chronicle* recently said of it: "With this magnificent volume Professor Maspero completes his great task, which has extended over nearly seven years, of writing a history of the Oriental world from the earliest times down to the death of Darius. The work has been great, as the progress of Oriental research has been so rapid and discoveries so numerous that to attain any finality seemed impossible; but the author has neglected nothing, and indeed the footnotes to these volumes show an almost Herculean labor of research among authorities in every land and every tongue, and add immensely to the value of the work. The work is beautifully produced, and the hundreds of illustrations are in highest style, and drawn from all sources." The New York *Mail and Express* calls attention to the fact that "this is not merely a stupendous record for the use of historical students: it is for popular reading as well. It is history in the best, the widest modern sense, which does not confine itself to dates and the deeds of great rulers, but deals with the daily activities of peoples, their religions, superstitions, and literature, their industries and intercourse—in short, with ancient human life in all its aspects."

EDWARD NOYES WESTCOTT.

Before the close of February, D. Appleton and Company were able to announce the 435th thousand of *David Harum*, which continues to be the most popular and successful book known in this country for many years. Under the title of David Harum in Figures the *New York Times* Saturday Review of February 17th prints the following: "'David Harum' is now selling in its 425th thousand. To print that number of copies 5,000 pounds of ink have been consumed, about 1,900 miles of thread have been used in the binding, and 5,865 reams of paper, weighing 87 pounds a ream, have been needed for the books. The 425,000 copies represent 2,932,500 papermaker's sheets, each

measuring $30\frac{1}{2}$ by 41 inches. If placed end to end the books would extend over a horizontal route for about fifty miles. If placed one upon the other they would make a tower seven miles high. And so the interesting axioms might be multiplied. But perhaps the greatest achievement is the part played by the plates from which the book is being printed. Only one set has been used to print the 425,000 copies. Over a year ago, when certain signs indicated that 'David Harum' was fast winning an extraordinary popularity, a second set of electrotype plates was cast, to be used in case of emergency; but so well has the printer done his work that this set has not as yet been pressed into service."

HERBERT SPENCER.

The second volume of Herbert Spencer's *The Principles of Biology*, which has been reset and revised, like the first, recognizes the rapid progress of biology in recent years. New chapters and three new appendices, with other additions, have increased Volume I to 706 pages. A new chapter and section, many new notes, and various other changes are presented in Volume II. This is the final and definitive edition of *The Principles of Biology*. The revision and augmentation of this second volume have occupied the last few years of this learned and distinguished man, who has almost attained the age of fourscore years. It was in 1867 that this work was first brought out. Mr. Spencer has kept accurate pace with the changes in this great field, and in the preface to his revised edition, written under date of October, 1899, he says, "On now finally leaving biological studies, it remains only to say that I am glad I have survived long enough to give this work its finished form." The *Brooklyn Eagle*, in referring to the completion of the revision of this great work, says: "While the publication of a definitive edition of this great work is the event that will hold the attention of the student and the scientist, the public, less concerned, perhaps, with the science, will note with interest and wonder the spectacle of this venerable philosopher and man of letters persisting, even to the age of fourscore, in that mental activity which has helped to give him a deathless place on the roll of the world's *savants*."

The International Geography, recently published by D. Appleton and Company, presents the authoritative descriptions and statements of a most remarkable group of geographical experts. The Right Hon. James Bryce, who writes of the Boer Republics, Sir W. M. Conway, Prof. W. M. Davis, Prof. Angelo Heilprin, Prof. Fridtjof Nansen, Dr. J. Scott Keltie, and F. C. Selous are among the seventy specialists whose contributions make up this important volume. The last few years have proved so rich in geographical discoveries that there has been a pressing need for a *review* of recent explorations and changes which should pre-

sent in convenient and accurate form the latest results of geographical work. The additions to our knowledge have not been limited to Africa, Asia, and the arctic regions, but even on our own continent the gold of the Klondike has led to a better knowledge of the region. The want which is indicated is met by *The International Geography*, a convenient volume for the intelligent general reader, and the library which presents expert summaries of the results of geographical science throughout the world at the present time. The book contains nearly five hundred illustrations and maps which have been specially prepared. It affords in the compact limits of a single volume an authoritative conspectus of the science of geography and the conditions of the countries at the end of the nineteenth century.

BIRD S. COLER.

Municipal Government, as illustrated by the Charter, Finances, and Public Charities of New York, is a most important and timely work by the Hon. Bird S. Coler, Comptroller of New York. The broad scope of the government of modern cities, the magnitude of the questions presented in New York since the extension of its limits, and the distinguished part taken by the Comptroller of New York in municipal affairs, commends Mr. Coler's book to the consideration of all who are interested in questions of municipal government. Mr. Coler surveys the existing conditions, analyzes the charter, and makes a striking exposure of abuses of public charities. He deals with the questions of water supply and franchises, and also discusses the relations of the individual citizen to the municipality. The importance of such a book for one who has proved his right to speak with authority will be readily appreciated. In his preface the author says: "No graver problems of government exist in civilized countries than those developed during the last quarter of the nineteenth century in the management of the affairs of American cities. Great principles of finance, education, charity, public health, and politics are involved in the government of large municipalities; and these questions, where they are presented on a scale so large, command the attention of all students of public affairs. During the past ten years the policy of public ownership and control of public property has developed into an established feature of municipal government, and valuable franchises are no longer distributed as political rewards or personal favors without protest. Methods of developing revenue-producing public property, and of utilizing the enormous waste of refuse incident to cleanliness and sanitation, are now studied thoroughly and intelligently with encouraging results. Everywhere there is a promising tendency toward thorough business methods in the conduct of the affairs of cities. The experiment of extending the limits of the city of New York to include almost one hundred suburban towns and villages, and the immediate application to the whole of the ordinances and regulations of a great city, has been watched with unusual interest by students

of municipal government all over the world. It was an act without exact precedent in any age or country, and while the success of consolidation was never doubted by its advocates, in almost all matters of detail the great municipality has not yet passed beyond the stage of experiment. The plan of government was not perfect. Many errors have been discovered, and some corrected. Much remains to be done, and for some years to come progress may be slow; but valuable lessons have been learned, and there is reason to believe that the mistakes of the past will not be repeated. A statement of conditions that exist and reports of progress made in the larger affairs of the greatest city of the New World may not be devoid of interest to students of municipal government."

The latest volume in the successful Literatures of the World Series, edited by Mr. Edmund Gosse, is *Russian Literature*, by K. Waliszewski. M. Waliszewski's brilliant work in his "Romance of an Empress" has gained for the author the favor of American readers. Many of these readers, however, may be unaware of the extent of M. Waliszewski's attainments, which have been so abundantly demonstrated in his literary criticisms and historical work that his selection as the historian of Russian literature in the admirably edited Literatures of the World Series is a pre-eminently fitting one. In this volume he has dealt with a theme comparatively little known and full of interest. From the *bilini*, or oral literature of Old Russia, and the Ostromir Codex, the earliest specimen of written Russian literature, down to the poets and novelists of the later nineteenth century, there are presented a series of peculiar and fascinating literary epochs which can only be set forth by a writer like M. Waliszewski, who is familiar with the developments of Russian history and imbued with the spirit of a people frequently misinterpreted and misunderstood. His study of Russian culture and Russian literary expression forms a lucid, significant, and most important critical history, which derives a peculiar interest from its elucidations of manners, customs, and life in general.

The multiplication of literary books upon fish and fishing, to say nothing of semi-scientific works upon the classification and habits of fish, and books upon tackle and flies, has nevertheless left a place vacant for a practical handbook which should describe the habits and environment of the fresh-water game fish commonly met with in this country, and explain in a simple and easily comprehensible way the methods of their capture. Mr. Eugene McCarthy, in his *Familiar Fish and how to Catch Them*, has produced an immediately useful and practical book which will be appreciated by fishermen, old and young, and by those who are interested in the simplest phases of outdoor Nature study. Mr. McCarthy's lifelong experience as a fisherman in this country and in Canada gives his book the practical value inherent in the work of the man who has himself tested and applied everything of which he writes. In American scientific nomenclature Mr. McCarthy's name is associated with that of the ouananiche of the

Lake St. John country. As one of the most experienced of American fresh-water fisherman he is able to speak with authority regarding salmon, trout, ouananiche, bass, pike and pickerel, perch, carp, and other fish which are the object of the angler's pursuit. His clear and practical counsel as to rods and tackle and their use, and the various details of camp life, render his book a most useful companion for all sportsmen and campers. Dr. David Starr Jordan has read the manuscript, and has lent the weight of his approval by writing an introduction. The book will be profusely illustrated with pictures and useful diagrams.

In the March number of the North American Review "John Oliver Hobbes" has published an elaborate and interesting review of *David Harum*, from which the following extract is quoted: "It would not be presumptuous to say, well remembering the magnificent ability of certain English authors of the present day, that not one could create a character which would win the whole English population as David Harum has won the American public. The reason is plain. With so many class distinctions, a national figure is out of the question. A national hero, yes; but a man for 'winterin' and summerin' with,' no. Social equality and independence of thought, in spite of all abortive attempts to introduce the manners and traditions of feudal Europe, are in the very air of the United States. One could not find an American man or woman of the true stock who had not known intimately, or who did not count among his or her ancestors, connections, relatives, a David Harum. The type, no doubt, is getting old—becoming more and more 'removed' from the younger generation. In the course of the next twenty years it may become so changed as to seem extinct, but it is a national figure—certainly the most original, probably the purest in blood. And the spirit of Harum is the undying spirit—no matter how much modified it may eventually become by refinement, travel, and foreign influence—of the American people. Individuals may change, but the point of view remains unalterable."

MISS ELLEN T. FOWLER.

Miss Ellen Thorneycroft Fowler, the brilliant author of "Concerning Isabel Carnaby" and "A Double Thread," has been engaged for some time upon a new novel of special interest and importance, which, however, may not be ready before the autumn. Meantime Messrs. D. Appleton and Company have prepared a new edition of her successful book "Concerning Isabel Carnaby," with portrait and biographical sketch. It may be recalled that Miss Ellen Thorneycroft Fowler is the eldest daughter of the Right Honorable Sir Henry Fowler, G. C. S. I., M. P., ex-Secretary of State for India, by Ellen (Imperial Order of the Crown of India), daughter of the late G. B. Thorneycroft, Esq., of Chapel House, Wolverhampton and Hadley Park, Salop. Miss Fowler has amused herself by writing stories and verses ever since she can remember.


Packer's Tar Soap

APPLETONS' POPULAR SCIENCE MONTHLY.

PROSPECTUS FOR 1900.

FOR a magazine whose field has no limitations except those of science, it is quite impossible to make a comprehensive announcement of its contents a year ahead. The Popular Science Monthly aims to keep its readers in touch with the most recent advances and discoveries as they are applicable to the promotion of human welfare and social progress. We believe that science is the force which has done the most in this direction in the past, and that it is what we must look to for growth in the future. We take advantage of every opportunity to secure articles that shall be entertaining as well as instructive without sacrificing accuracy, and we especially seek those authors who have the ability to write upon scientific subjects in a clear and instructive way.

The most characteristic feat re of the nineteenth century, and especially of its latter half, is the truly wonderful advance of science, both theoretical and practical. Coincident with this advance, and very largely dependent upon it, has been the unprecedented development of commerce and manufactures, of social organization and national wealth. A comparison of the potentiality of an unskilled laborer of one hundred years ago with that of a like workman of to-day brings out most strikingly what this scientific advance has accomplished in solving the problems of life and raising the standard of comfort; so that the luxuries of a few years ago are the necessities of to-day, and new pleasures have been added and even become common which were formerly beyond the reach of the most wealthy. In view, then, of this prominently scientific aspect, the most important and instructive portion of nineteenth-century history will be that of its scientific achievements, which, as Mr. Alfred Russel Wallace has so well pointed out in his "Wonderful Century," far exceed in number as well as in importance those of all the centuries that have preceded it.

A CENTURY OF SCIENCE.

Believing that no more appropriate and useful way of signalizing the completion of this century could be adopted than that of publishing during its closing year a history of its scientific work, we have arranged for such a series of articles from the leading scientific writers of the world: Sir Robert S. Ball in Astronomy; President Arthur T. Hadley in Economics; Prof. Joseph Le Conte in Geology; the Hon. Andrew D. White in University Education; Prof. W. M. Flinders Petrie in Archæology; M. W. Haffkine in Preventive Inoculation; Prof. W. M. Davis in Meteorology; Prof. F. W. Clarke in Chemistry; and others of like standing in their specialties.

NEW DISCOVERIES AND INVENTIONS.

The Monthly will continue to give accounts of the course of discovery and of new developments in pure science; and careful writers familiar with their subjects will be engaged to describe whatever occurs in this field as soon as it has assumed definite form. Recognizing that the highest service that can be rendered by knowledge is in its use for the improvement of man's condition, special attention will be given to the adaptations of discovery to practical ends in the arts and industries, in the betterment of social life, and in the development of a wiser statesmanship for the administration of civil affairs

THE PRACTICAL APPLICATIONS OF SCIENCE.

These are the tests by which science, and indeed any other like system, must be judged; and not only because the study of these applications is of value in leading to a general appreciation of the beautiful correlation between pure science and practical life, but more, perhaps, on account of the actual value of the information, we have always heretofore, and shall still more in the future, devote a certain portion of our space to their discussion. Among the earlier papers to appear will be a series of illustrated articles by William Baxter, Jr., C. E., giving a comprehensive account of the automobile in its various forms, including a discussion of the relative merits of the various types.

THE RACE QUESTION.

The question of the adjustment of the relations of the races will be considered as offering some of the most serious and immediate difficulties our people have to confront, and one to which the thoughts of the best students of affairs are anxiously directed. Among the articles bearing upon this subject will be several by Prof. N. S. Shaler, of Harvard University, dealing with various aspects of the negro question. Professor Shaler, who spent his early life in the South, throws much new light on its practical aspects.

CURIOSITIES OF NATURE.

No subject more quickly and universally enlists attention or holds it longer than that of natural history. From the apparently inexhaustible store of novelties it affords, the curious blind fishes of North America—those remarkable products of retrograde evolution—are marked for early description in several articles, accompanied by numerous illustrations, from the pen of Prof. Charles Eigenmann, who has made a special study of these fishes and is the acknowledged authority respecting them.

THE ADVANCE OF WOMAN.

Recognizing as one of the most striking social features of the life of the nineteenth century the enlargement of woman's sphere and the extension of her privileges, the Popular Science Monthly will endeavor to keep abreast of this movement.

COLONIAL QUESTIONS.

The important political questions arising through our recent acquisition of outlying territory will receive considerable attention. Two articles which will appear in early numbers, under the title Colonies and the Mother Country, take up the question of their proper relations.

MORALS AND EXPEDIENCY.

The drink evil, and vivisection, two of the most pressing moral questions now engaging the attention of society, are scheduled for early treatment; and we have already arranged for several articles taking up important questions connected with modern religious tendencies.

EDUCATION.

Of equal importance with all these branches of knowledge, and an essential prerequisite to receiving and rendering them available for use, is education. The Monthly has in the past given this subject prominent attention and preference, and will continue to do so. We have always aimed to make the articles in this field not only of general philosophical interest, but more especially to select subjects and modes of treatment which should be suggestive and practically valuable to the working teacher.